STRATIGRAPHY OF THE WOODBINE FORMATION TARRANT COUNTY, TEXAS

A FIELD TRIP GUIDEBOOK

Second Annual Meeting

THE SOUTH-CENTRAL SECTION

of

The Geological Society of America, Inc.

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TARRANT COUNTY, TEXAS

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STRATIGRAPHIC NOMENCLATURE OF THE WOODBINE FORMATION TARRANT COUNTY, TEXAS

by

Charles F. Dodge

Abstract

The Woodbine Formation of Tarrant County, Texas, consists of four rock units, which are, in ascending order: 1) a basal shale, 2) a lower sandstone, 3) an upper shale with abundant, relatively small sand bodies, and 4) an upper massive sandstone.

The basal shale is an hitherto-unnamed, but established, rock unit which can be traced from Tarrant County for 100 miles to both the north and the south, justifying formal nomenclature which is given here. The lower sandstone is the Dexter Sand of Taff. The upper shale with its lenticular sandstone developments is the Lewisville of Hill. The upper sandstone is a facies of the upper Lewisville of the type locality of the latter. The sandstone, a conspicuous unit of Tarrant and adjacent counties, marks the mappable top of the Woodbine and needs formal nomenclature, which is given here. The term "Euless" is a hybrid of rock and time-rock definitives, is without determinable succession of reference, and is rejected here.

In Tarrant County, beds immediately below (Grayson) and above (Eagle Ford) the Woodbine are unequivocally marine and are disconformable with it. But, the temporal significance of the surfaces remains to be established accurately, although it appears much less significant than has been inferred in the past.

Woodbine sediments represent an excellent example of the paralic environment, with paralic subenvironments such as offshore bars, channel sands, mud flats, shallow lagoonal deposits, swamp or marsh deposits, and shallow marine blanket sands represented in the over-all section.

Introduction

The Woodbine Formation was named by R. T. Hill (1901). Prior to this time, B. F. Shumard (1860) referred to this unit as the "Arenaceous Group," and G. G. Shumard (1886) placed the arenaceous beds of Grayson County, Texas, in his "Tertiary System." R. T. Hill clarified the various existing misunderstandings on the unit which occupies the Woodbine stratigraphic position and designated it the "Timber Creek Group." Since the name "Timber Creek" was preoccupied, Hill redesignated the unit the "Woodbine Formation," a name derived from a small town in east-central Cooke County.

The two recognized major members of the Woodbine are the Dexter, named by Taff (1893) for a small village in northeastern Cooke County, and the Lewisville, named by Hill (1901) for the town of Lewisville in Denton County. Bergquist (1949), working in Cooke, Grayson, and Fannin Counties, 30 to 100 miles north of Tarrant County, retained the name "Dexter," but subdivided the Lewisville into the lower, Rainbow Member; lower middle, Red Branch Member; Lewisville Member; and upper, Templeton Member. Dodge (1952) recognized four lithologic members in the Arlington area of Tarrant County: the Basal Clay, the Lower Sandstone, the Upper Clay, and the Upper Sandstone. Hazzard, Blanpied, and Spooner (1947) introduced the names "Euless Formation" and "Pine Bluff Member" for parts of the Lewisville Member. They also raised the Woodbine to group status. These terms will be expanded under the heading of stratigraphy. Stephenson (1952) retained the name "Euless" with only member rank in his Woodbine stratigraphy and moved Moreman's (in Adkins, 1933) Tarrant Member from its position as the basal member of the Eagle Ford Formation into the upper Lewisville.

Beall (1964a) treated the Woodbine of the outcrop area of Johnson, Hill, and McLennan Counties as a group made up of the Dexter and Lewisville Formations and graded both units into the Pepper Formation to the

east in the subsurface and to the south and east on the outcrop. This interpretation follows that of Adkins and Lozo (1951).

Stratigraphy

R. T. Hill (1901, p. 297) subdivided the Woodbine Formation as follows:

> The general sequence of beds, so far as they can be established from the study of the outcrops between the Trinity and Red River, will now be stated. This sequence may prove variable after further study:
>
> 1. The lowest beds are usually impure clay, which is often sandy and lignitic.
>
> 2. An extensive formation of yellow ferruginous sandstone and brown siliceous ironstone, in which impressions of dicotyledonous leaves are sometimes found. These are the Dexter sands of Taff.
>
> 3. Lignitic sandy clays and sands, frequently accompanied by sulphate of iron, magnesian salts, etc. The sands also oxidize into heavy, siliceous, dark brown iron ore in places. The subdivision is characterized by an extensive molluscan fauna, which is elsewhere alluded to and which may be characterized as the Aquilaria cumminsi zone. There are the Lewisville beds.
>
> 4. Less ferruginous sands and clays, and in places more calcareous and fossiliferous, gradually passing into the bituminous shale of the Eagleford Formation. The upper limit of these beds ends with the zone of Ostrea columbella Meek.

Hill (1901) referred the two lower divisions to Taff's (1893) Dexter Sands and the two upper units to his Lewisville beds. Whatever their names, the four rock units can be identified and compose the Woodbine in Tarrant County.

Hazzard, Blanpied, and Spooner (1947) proposed the term "Euless Formation" to define a surface stratigraphic unit located between the basal Pine Bluff Member (Hazzard, 1939) of the Lewisville Formation and the base of the Dexter Sands. The Dexter was given member status in the Euless Formation.

Unfortunately, Hazzard's type section for the Euless Formation, as given in Stephenson (1952, p. 10), is much in error. Primarily, what Hazzard took for the Dexter Sand is in reality a sandstone channel fill in the Lewisville Member. The top of the Dexter Member crops out approximately 3 miles to the west-southwest in a roadcut on State Highway 183 at an elevation of about 560 feet. The channel sandstone is 35 to 40 feet stratigraphically above the top of the Dexter at this locality.

Hazzard's (1947) Pine Bluff Member of the Lewisville, described as marine, tuffaceous sand and clay with gravel lenses, is not evident in the Lewisville Member as exposed in Tarrant County, Texas; and its extension via the subsurface, from its type locality in Red River County, Texas, about 145 miles to the east-northeast, is unwarranted.

The term "Euless Formation" should not be used as a rock stratigraphic unit name since it was based on a miscorrelation. Further, no complete type section was published by the originators or later users of the term. Finally, the Euless Formation was never more than the lower half of the well-defined Lewisville beds of Hill (1901), plus the Dexter Sands of Taff (1893).

Bergquist (1949) has mapped and described the Woodbine stratigraphy of Cooke, Grayson, and Fannin Counties, Texas. This area is located 30 to 100 miles north and northwest of Tarrant County. Bergquist subdivided the Gulf Series into an unnamed post-Grayson shale, the Dexter Member with the sporadic Rainbow Clay overlying it, the Red

Branch Member, the Lewisville Member, and the Templeton Member. The writer has visited Bergquist's Rock Creek type locality for the unnamed post-Grayson shale and is of the opinion that this unit is the equivalent of Taff's (1893) Basal Clays. The Dexter Member is a well-defined unit in this area and is correlative to Taff's (1893) original Dexter Sands.

The author has made field checks of Bergquist's Rainbow Clay, Red Branch Member, and Lewisville Member of the Woodbine Formation in the Cooke, Grayson, and Fannin County area. Field correlations from the type Lewisville section of Taff (1893) in Denton County indicate no major change in lithology. In fact, Bergquist stated that the Red Branch and Lewisville Members coalesce down dip into the subsurface as an expanded Lewisville Member of the Woodbine Formation. The Rainbow Clay of Bergquist (1949) is lithologically more akin to the clay and shale of the Lewisville Member than to the sandstone of the Dexter Member, and this informal unit, along with the Red Branch Member, should be placed in the Lewisville Member of the Woodbine Formation.

Bergquist (1949) introduced the term "Templeton Member" for a fossiliferous shale and glauconitic sandstone overlying the Lewisville Member. Moreman (1942) placed beds of this interval in Tarrant County in his basal Tarrant Member of the Eagle Ford Shale. Stephenson (1952) concluded that the Templeton Member is uppermost Woodbine Formation; however, he did not attempt to extend this member out of the Red River area.

The author proposes the following stratigraphic sequence and formal rock-unit designation in eastern Tarrant County, Texas:

	Eagle Ford Formation
Gulf Series	Woodbine Formation
	Arlington Member*
	Lewisville Member
	Dexter Member
	Rush Creek Member*
	-----unconformity-----
Comanche Series	Washita Group

This designation is based in part on the previous work of various investigators of Woodbine stratigraphy and in part on work by the present investigator. The names of the two new rock units in the Woodbine Formation of Tarrant County are shown above with astericks. Type localities and detailed sections for both these units will be given in a later part of this paper.

Taff (1893) recognized the Basal Clays of the Woodbine Formation. Hill (1901) described clay and arenaceous clay at the base of the Woodbine, overlying Comanche Series units, in Cooke, Grayson, Denton, and Tarrant Counties. Winton (1925, p. 37) found clay and arenaceous clay above the Grayson Marl at the Acme Brick pit in Denton, Denton County. Bybee and Bullard (1928, p. 40) reported 15 feet of sandy clay, with a light-yellow sand 3 feet thick at its base, overlying the Grayson Marl in an exposure on Walnut Creek, one mile south of Bloomfield in Cooke County, Texas. Bullard (1931, p. 55) found a clay and sandstone zone overlying the Grayson Marl in northwestern Grayson County.

Bergquist (1949) reported a post-Comanche Series shale at several localities in Grayson County. Dodge (1952, p. 69) described a clay and sand member overlying the Grayson Marl on Rush Creek, about 2 miles west-southwest of Arlington in Tarrant County. Beall (1964b, fig. 5, p. 20) described a clay unit at the base of the Woodbine in his locality X in central Hill County.

It is the opinion of this writer that a definite rock unit made up of clay and shales, and at some localities with interbedded sandstone and conglomerate, underlies the Dexter Sands and overlies the Comanche Series with regional or local angular unconformity.

Taff (1893) was the first to describe the unconformable nature of the Upper and Lower Cretaceous beds. Most investigators since that time, with the notable exception of Scott (1926), have agreed with this interpretation.

In most localities, the uppermost Comanche unit, the Buda Limestone, is completely eroded. Adkins (1933, p. 401) states:

> From Cerrogordo, Arkansas, westward to Grayson County, Texas, the Woodbine unconformably rests on a beveled surface of Comanche formations ranging upwards from Kiamichi to Grayson. Thence southwards to Bosqueville, McLennan County, the Buda is absent and the Gulf series rests on Grayson marl.

However, Buda Limestone in isolated outcrops overlying the Grayson Marl has been reported in Denton County by Winton (1925, p. 30) and in Hill County by Beall (1964a).

The present investigator finds considerable evidence for the unconformity. The Grayson Formation of the Washita Group, Comanche Series, underlies the Woodbine Formation. The Grayson Marl, ranging from 80 to 100 feet in thickness in Tarrant County, is underlain by the Main Street Formation. The Main Street Formation thickens from 25 feet in the north of Tarrant County to 50 feet in the south.

Near the village of Smithfield, beds of Main Street locally dip to the north and northwest; yet, this dip is not expressed in the overlying Grayson Marl. Just north of Handley the Rush Creek Member of the Woodbine overlies only 12 feet of Grayson Marl.

The basal conglomerate which will be described later in localities A and C is supporting evidence for the unconformity, as is a thin erosional remnant of Buda Limestone overlying the Grayson Marl at Grayson Bluff in south-central Denton County. This erosional surface may have had several tens of feet of relief and may account for the thick Rush Creek Member described at locality F.

It is here proposed that the Basal Clays of Taff (1893) and the Basal Clay Member of Dodge (1952) be designated the "Rush Creek Member" of the Woodbine Formation. It is further proposed that the type section be that described by Dodge (1952, p. 69-70) on Rush Creek in Tarrant County, Texas. This section is described below and is shown on the enclosed location map (fig. 1) at locality A.

The contact relationship between the Rush Creek Member of the Woodbine Formation and the underlying Washita Group rocks has been discussed above. This unit is gradational upward into the Dexter Member.

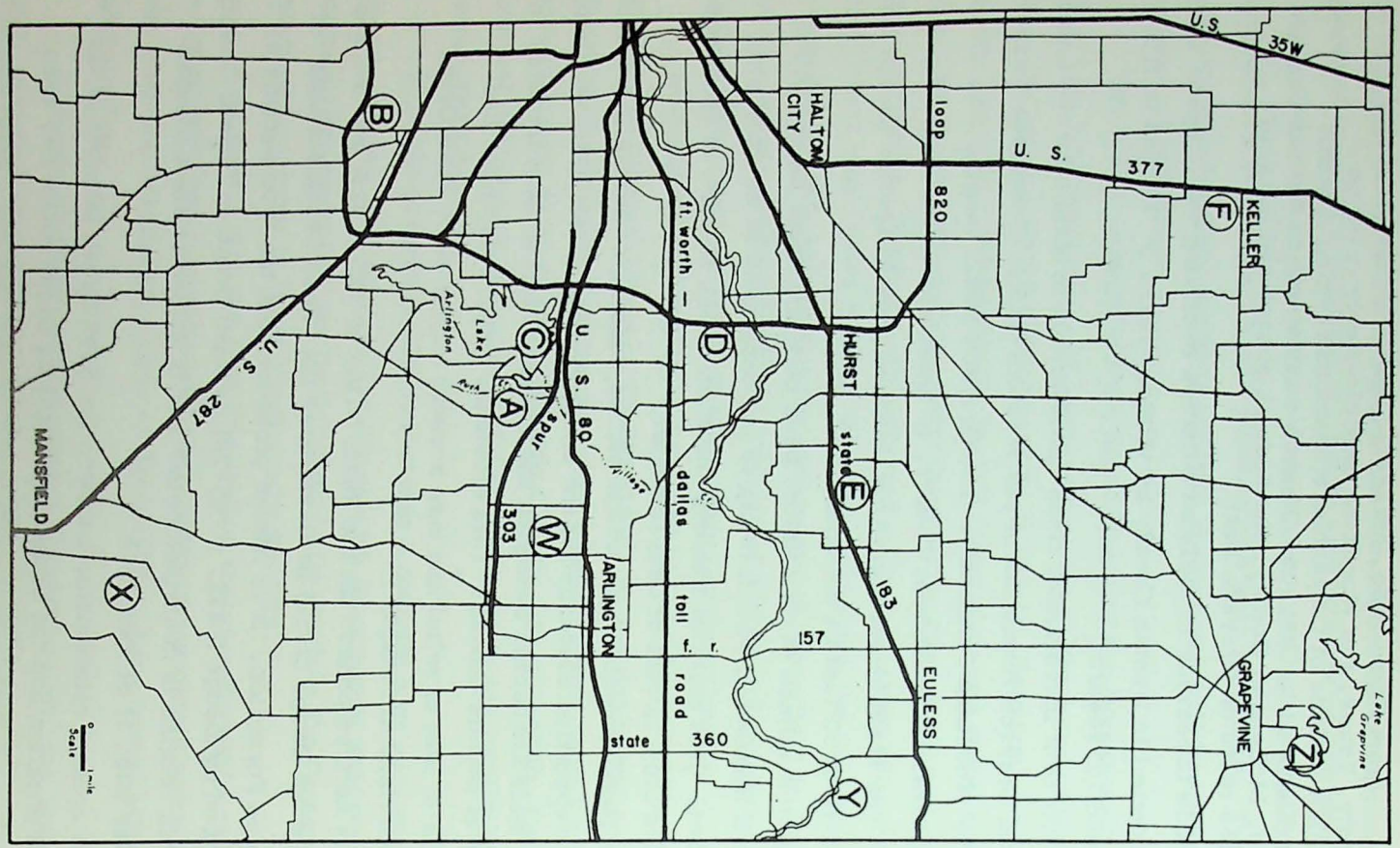

Figure 1.-- Map of the eastern half of Tarrant County, Texas, showing the various localities cited in the text.

The last gray to brown to black clay or shale in the section is taken as the top of the Rush Creek Member.

Type Section of Rush Creek Member on Rush Creek, Tarrant County, Texas

Locality A

Woodbine Formation	Feet
Dexter Member	
Reddish-brown, cross-bedded sandstone	6.0
Tan to white, laminated sandstone	0.6
Total exposed thickness	6.6
Rush Creek Member	
Irregularly interbedded white to yellow sand and gray to brown clay	1.3
Tan to orange sandstone	0.2
White, gray, to tan sandstone	0.2
Gray clay	0.1
Interbedded white sand and gray clay	0.8
Bluish-gray clay	0.1
White to tan sandstone	0.4
White to light-tan sand and gray clay	0.3
Interbedded tan sandstone and lignite	0.5
Lignite in sandy clay	0.1
Interbedded tan sandstone and lignite	0.3
Tan to gray, laminated sandstone	0.3
Interbedded tan sandstone and blue clay	0.3
Tan, laminated sandstone	0.2
Interbedded tan sand and gray clay	0.5
Interbedded yellow sand and gray clay	0.4
Bluish-gray clay	0.2
Yellow to light-gray sandy clay	0.1
Dark-red ironstone	0.1
Bluish-gray clay	0.2
Dark-red ironstone	0.1
Yellow sandstone mottled black	0.5
Dark-gray to brown clay, locally stained yellow; high carbonaceous content; some ironstone concretions and large gypsum crystals	4.5
Yellow to tan, fine sand with boulders of gray, calcareous clay	0.5
Total thickness	12.2
Unconformity	

Grayson Formation	Feet
Bluish-gray to tan, calcareous clay	1.5
White to tan limestone containing Gryphaea and Pecten	0.5
Total exposed thickness	2.0

A major part of the past confusion concerning the basal unit of the Woodbine is due to its extreme variability. Several measured sections from various localities in Tarrant County are listed below. Locations of the sections are designated by letter and are shown on the enclosed location map.

Section of Rush Creek Member on Loop 820 South

Locality B

Woodbine Formation	Feet
Rush Creek Member	
Gray to brown, fissile shale; few selenite crystals	4.2
Red, thinly laminated sandstone; heavy ferruginous cement	1.3
Tan, massive, friable sandstone	3.2
Light-brown, cross-bedded sandstone; ferruginous cement	3.5
Red, clayey siltstone; ferruginous cement	0.2
Light-brown to tan, thinly laminated, friable sandstone	6.9
Red sandstone; heavy ferruginous cement	1.0
Total exposed thickness	20.3
Unconformity	
Grayson Formation	
Gray, calcareous shale with white limestone stringers; fossiliferous	8.6
Total exposed thickness	8.6

Section of Rush Creek Member at Spillway Cut, Lake Arlington

Locality C

Woodbine Formation	Feet
Dexter Member	
Red to brown, fine-grained, cross-bedded sandstone; ferruginous cement	15.0

	Feet
Tan to brown, argillaceous sandstone with a few gray clay partings	7.9
Total exposed thickness	22.9

Rush Creek Member

Gray, arenaceous clay interbedded with fine-grained, tan to white, friable sandstone lenses	3.3
Dark-gray to black, fissile shale with a few tan to red, very thin siltstone and sandstone stringers with ferruginous cement; scattered selenite crystals	10.5
Tan to white, finely laminated to ripple marked, friable sandstone interbedded with gray, very thin clay beds; ferruginous claystone along some partings; sandstone beds vary from 0.1 to 2.9 feet	14.5
Brownish-red conglomerate with heavy ferruginous cement; fish teeth and vertebrae, bone and shell fragments, and ferruginous clay chips	1.2
Total thickness	26.5

Unconformity

Grayson Formation

Interbedded gray, calcareous shale and white, fossiliferous limestone	15.0
Total exposed thickness	15.0

Section of Rush Creek Member Exposed on Sandy Lane Road, One Mile North of the Dallas-Fort Worth Turnpike

Locality D

Woodbine Formation	Feet
Dexter Member	
Tan to white, fine-grained, cross-bedded sandstone	7.0
Tan to light-brown, fine-grained sandstone with a few gray clay stringers interbedded	6.5
Total Exposed thickness	13.5

Rush Creek Member

Dark-gray to black, fissile shale	5.5
Tan to white, thinly laminated to slightly cross-bedded, fine-grained, friable sandstone with scattered gray clay partings	19.0
Total thickness	24.0

Unconformity

Grayson Formation

Light-gray, calcareous shale with white, fossiliferous limestone stringers	6.0
Total exposed thickness	6.0

Section of Rush Creek Member Exposed in Roadcut 500 Feet North of State Highway 183 and 1.6 Miles Southwest of Bell High School in Euless, Tarrant County, Texas

Locality E

Woodbine Formation	Feet
Dexter Member	
Tan to brown, fine-grained sandstone with ferruginous claystone interbedded	1.3
Light-gray, fissile shale	0.3
Tan to brown, massive, fine-grained sandstone with ferruginous cement	4.0
Total exposed thickness	5.6
Rush Creek Member	
Tan, fine-grained sandstone interbedded with dark-gray, fissile shale	2.0
Tan to white, friable sandstone	0.5
Dark-gray, fissile shale	1.7
Tan to white, friable sandstone	0.7
Gray, arenaceous shale	0.4
Tan to white, finely laminated sandstone	1.3
Dark-gray to brown, arenaceous clay	4.4
Tan to white, finely laminated sandstone	0.5
Dark brownish-red conglomerate composed of ferruginous claystone chips	0.9
Dark-gray, fissile shale with thin, white sand partings	2.1
Total exposed thickness	14.5

Section of Rush Creek Member Exposed on a Hillside 0.6 Miles South-Southeast of Keller, Tarrant County, Texas

Locality F

Woodbine Formation	Feet
Dexter Member	
Reddish-brown, fine-grained, cross-bedded sandstone with ferruginous cement	26.0
Total exposed thickness	26.0
Rush Creek Member	
Dark-gray to black, fissile shale	13.0
White to light-gray, massive, friable sandstone	12.0
Dark-gray, fissile shale	4.5
Dark-red, ferruginous claystone	0.5
Gray clay	3.0
Brown to black clay with carbonized wood fragments	2.5
Brown, fine-grained sandstone with ferruginous cement	0.5
Brown to dark-gray carbonaceous clay	9.0
Total thickness	45.0
Unconformity	
Grayson Formation	
Light-gray, fossiliferous, calcareous shale	7.0
Total exposed thickness	7.0

The section at locality F is the thickest measured in Tarrant County. This may be a result of one of two factors. First, the Woodbine Formation is known to thicken from south to north, and this may represent regional thickening. The basal unit of the Woodbine at the Acme Brick pit in Denton, Denton County, approximately 20 miles to the north-northeast, is reported in excess of 40 feet by Winton (1925). Another possible explanation for the thick Rush Creek section at locality F is the filling of a depression on the pre-Gulf Series erosional surface on which this unit was deposited.

Taff's (1893) Dexter Sands seem to be accepted by most investigators of the Woodbine. Hill (1901) made the Dexter Formation the lower part of his Woodbine Formation. Winton and Adkins (1919), Winton and

Scott (1922), Adkins (1924), Winton (1925), Bybee and Bullard (1928), and Bullard (1931) all mapped the Woodbine as a formation. However, most of these investigators recognized Hill's subdivision of the Woodbine Formation into the upper Lewisville Beds and the lower Dexter Sands. Adkins (1933) raised the Woodbine to group status with the Dexter Formation as the lower unit. Hazzard, Blanpied, and Spooner (1947) placed the Dexter Sandstone Member in their Euless Formation, which they interpreted as the lowermost unit of the Woodbine Group. Bergquist (1949) mapped the Dexter Member of the Woodbine Formation in the Red River area. The type locality of Taff's (1893) Dexter Sands is in the mapped area. Stephenson (1952) mapped a sandstone unit, termed the "Lower Sandstone Member" of the Woodbine Formation, in the Arlington area of Tarrant County, Texas. He considered this unit as corresponding in general with the Dexter Sands of Taff (1893) and Hill (1901). Lee (1958) recognized the Dexter Formation as a part of his Woodbine Strata of Hill County, Texas; however, he did not attempt to map the separate units of the Woodbine in his study.

It is recommended that the term "Dexter Sands" as originally proposed by Taff (1893) be designated the "Dexter Member" of the Woodbine Formation. This unit has been either mapped or recognized from the Red River area of Fannin County westward approximately 40 miles into Cooke County; then southward for about 150 miles through Denton, Tarrant, Johnson, and Hill Counties; and into McLennan County.

The term "Lewisville Beds" as revised by Hill (1901) has the same general acceptance as the term "Dexter Sands." Hill simply redesignated Taff's (1893) original Timber Creek Beds type section as the "Lewisville Beds," after the village in Denton County about one mile south of the type locality. This name change was necessitated by the preoccupation of the term "Timber Creek." Typical Lewisville carbonaceous clay, gray shale, and lenticular sandstone have been reported all along the Woodbine outcrop belt. The writer recommends the redesignation of the term "Lewisville Member" to include only the carbonaceous clays, gray shales and lenticular sandstone bodies of Hill's (1901) original Lewisville Beds. An excellent

exposure of this unit may be seen just south of the Trinity River on Farm Road 157. A description of this section, taken from Dodge (1952, p. 74-75) is given in the discussion for locality 2--site B, following the road log.

It is also proposed here that the uppermost fossiliferous sandstone unit of Hill's (1901) Lewisville Beds be designated the "Arlington Member" of the Woodbine Formation. This unit is well exposed in Tarrant County and was reported by Taff (1893, p. 289) near Osceola in Hill County. Beds of similar lithology, overlying carbonaceous clay and overlain by typical Eagle Ford "laminated blue clays," were reported by Taff (1893, p. 289) from the original type section on Timber Creek, Denton County, Texas. Winton and Adkins (1919, p. 77) reported about 12 feet of fossiliferous sandstone overlying brown shale at Tarrant Station in eastern Tarrant County. Winton and Scott (1922, p. 32) found 13 feet of similar sand at the top of the Lewisville one mile west of Grandview in Hill County.

Dodge (1952, p. 76) described a section near Dorothy Siding, two miles east of Tarrant Station in east-central Tarrant County. This unit was designated the "Upper Sandstone Member" of the Woodbine Formation. Other sections in Tarrant County, including the designated type section, are listed below:

Type Section of Arlington Member Exposed in Roadcut in the 2000 Block of West Park Row Street, Arlington, Texas

Locality W

	Feet
Quaternary Terrace	
Dark-red conglomerate composed of subangular to subrounded ferruginous claystone pebbles in a fine-grained sand matrix	2.0
Total exposed thickness	2.0
Woodbine Formation	
Arlington Member	
Shell conglomerate containing Ostrea sp. and Exogyra sp. in a fine sand matrix	1.2

	Feet
Light-tan, fine-grained sandstone with calcareous cement; a few gray clay partings	5.0
Tan to reddish-brown, thinly laminated, fine-grained, friable sandstone with ferruginous cement; numerous very thin clay partings along ripple surfaces; upper part slightly cross-bedded	29.2
Total thickness	35.4

Lewisville Member

Dark-gray, fissile shale	7.0
Total exposed thickness	7.0

Section of Arlington Member Located Two Miles Northeast of Mansfield, Tarrant County, Texas

Locality X

Eagle Ford Formation

	Feet
Dark-gray to black fissile shale	6.0
Total exposed thickness	6.0

Woodbine Formation

Arlington Member

Shell fragment conglomerate in brown, arenaceous clay matrix	1.3
Tan, fine-grained cross-bedded sandstone with ferruginous cement	11.7
Light-tan, fine-grained sandstone with gray clay partings, ferruginous cement	2.3
Light-gray, fissile shale	0.2
White, very fine-grained, friable sandstone	0.2
Total thickness	15.7

Lewisville Member

Dark-gray to gray, arenaceous clay with ferruginous claystone stringers and selenite crystals	9.2
Dark-brown, slightly arenaceous clay with carbonized wood, shell fragments, and selenite crystals	1.3
Total exposed thickness	10.5

Section of Arlington Member Measured Two Miles East of Tarrant Station, Tarrant County, Texas

Locality Y

	Feet
Eagle Ford Formation	
Blue-black, fissile shale	3.0
Total exposed thickness	3.0
Woodbine Formation	
Arlington Member	
Brown to tan, fine sandstone, cross-bedded	4.4
Shell conglomerate containing Ostrea sp. and Exogyra sp.	2.9
Yellow to gray, sandy clay	1.8
Yellow to tan, fine-grained sandstone parted by thin gray clay seams; some ironstone concretions	11.2
Total thickness	20.3
Lewisville Member	
Tan to brown, fissile shale with thin sand and ferruginous claystone partings	3.0
Black to brown, carbonaceous clay with compressed carbonized tree limbs and trunks, selenite crystals	2.5
Total exposed thickness	5.5

Section of Arlington Member Measured on Silver Lake Branch of the Grapevine Reservoir, Tarrant County, Texas

Locality Z

	Feet
Eagle Ford Formation	
Black to dark-gray, fissile shale	9.0
Total exposed thickness	9.0
Woodbine Formation	
Arlington Member	
Reddish-brown, fine-grained, cross-bedded, fossiliferous sandstone with ferruginous cement	7.8
Tan, thinly bedded, fine-grained sandstone with calcareous cement	6.0
Total thickness	13.8

Lewisville Member	Feet
Dark-gray to black clay with ferruginous claystone partings	9.7
Total exposed thickness	9.7

The Arlington Member has been traced by the writer from northeastern Tarrant County through Denton County and into Grayson County. Bergquist (1949) showed a fossiliferous, fine-grained, glauconitic sandstone with calcareous cement at the top of his Lewisville Member at 10 localities in Grayson and Fannin Counties. The writer has also traced this unit south through Johnson and Hill Counties.

Although much more detailed work needs to be done on the Arlington Member, it appears that the unit may represent three facies. The western-most exposures of the Arlington Member are nonfossiliferous, except for the "oyster reef" capping, and are made up predominantly of finely laminated, ripple-marked sandstone with very thin clay partings. The lack of fossils and major cross-bedding along with ripple marking suggests a very low-energy environment, perhaps littoral or very shallow neritic.

To the east, strong cross-bedding of the "cut-and-fill," or "festoon," type is present, and fossils are more numerous. Eastward it grades into a flaggy, calcareous-cemented, fossiliferous sandstone, which is also cross-bedded; and in places ripple markings are preserved. Lenses of conglomerate up to 1.5 feet thick are present in scattered localities. McNulty and Slaughter (1962) and McNulty (1964) have described fish teeth from this conglomerate. Davidson (1963) has described crustaceans from this facies of the Arlington Member, and the ammonites of the upper Woodbine Formation are from this part of the unit. The above data would tend to place the depositional environment of the eastern Arlington Member of Tarrant County in marine waters of higher energy potential.

The Lewisville Member is gradational upward into the Arlington Member. The contact is usually taken at the last gray to brown clay or shale in the underlying Lewisville Member. The upper contact is, at least in part, unconformable. In some localities the tan clays and thin sand

stringers of the Tarrant are present. In other areas, the massive, calcareous-cemented Arlington is overlain directly by the dark-gray to black fissile shales of the Eagle Ford Formation. The upper contact problem will be discussed in detail in a paper by J. Dan Powell on the Tarrant, which appears elsewhere in this guidebook.

Bergquist's (1949) Templeton Member is not present in Tarrant County. Stephenson (1952) stated that the unit extends southward from the type area in Grayson County only into central Denton County. Figure 2 shows the subdivision of the Woodbine by various authors from Taff (1893) to the present.

Interpretation of Environment

The first comments on probable depositional environments of Woodbine sediments were made by Hill (1901). He cited the leaf impressions of the Dexter Sands and the lignite beds of the Lewisville Beds as indicative of a shallow-water, littoral origin for the sediments. Stephenson (1918) stated that the basal member of the Gulf Series, the Woodbine Sand, was probably deposited in the shallow waters of a sea transgressing over the post-Comanche erosional unconformity.

Berry (1922), on the basis of a detailed study of the Woodbine plant remains from the Arthurs Bluff area of Grayson County, stated that, from this floral evidence, the Woodbine might be interpreted as being made up of continental, deltaic, and marginal marine deposits.

Scott (1926) published a radically different interpretation of the Woodbine's genetic history. He considered the Woodbine to be Comanchean in age. He believed it represented the major regression of the Comanche seas to the southeast prior to the major Gulfian-Eagle Ford transgression. He stated that some workers regarded the Woodbine as a river delta, and he concluded that rivers may have contributed some sediment to the over-all section. Also, he suggested that the Red River part of the

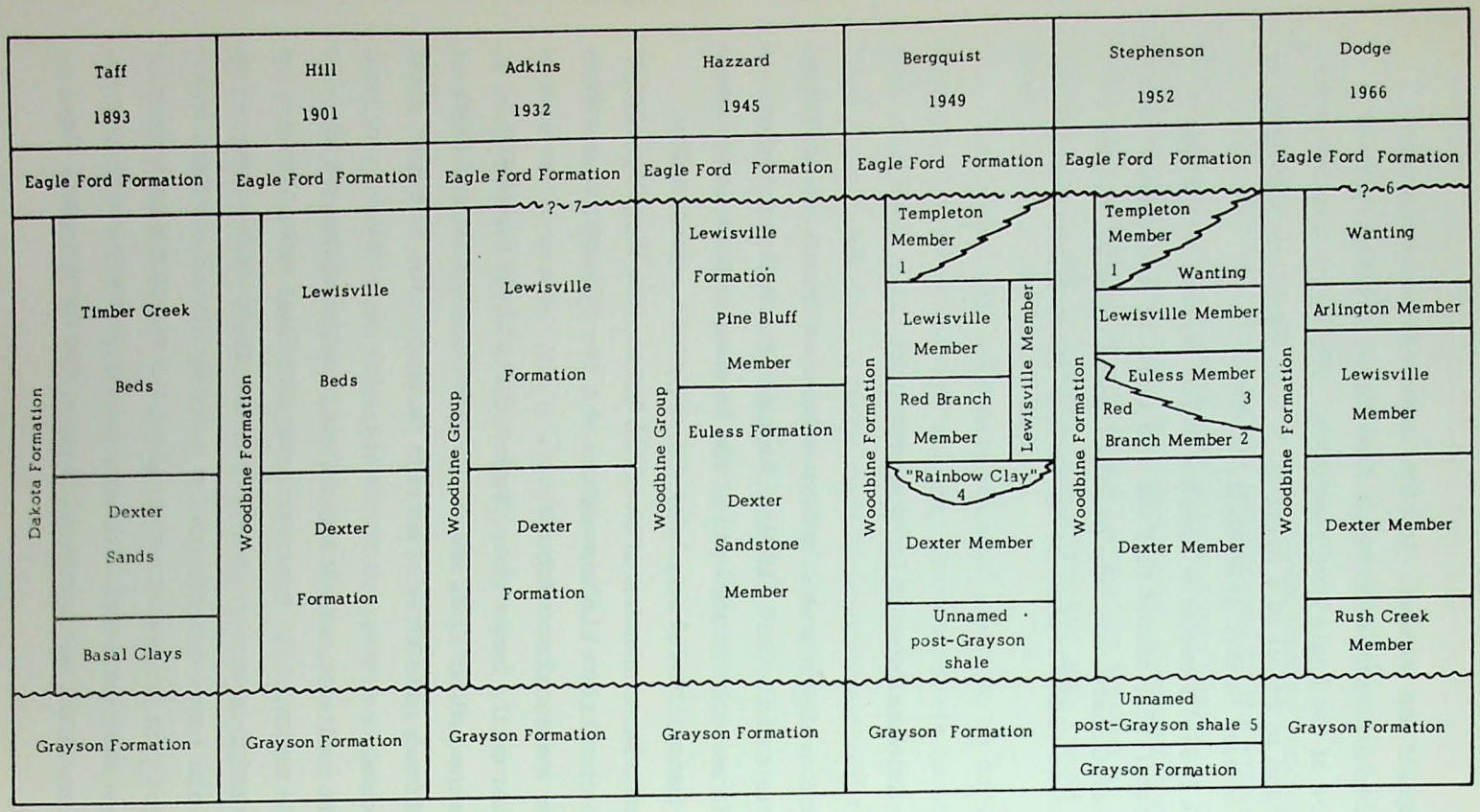

Figure 2.--Correlation chart for the Woodbine Formation of North Texas. (1) Not present south of central Denton County. (2) Not present in Tarrant County. (3) Lower Lewisville. (4) Not everywhere present. (5) Placed in Comanchean by Stephenson. (6) and (7) Relationship questionable.

Woodbine might be in part deltaic. In a discussion before Dallas petroleum geologists in 1931, he stated that he believed the basal clay beds of the Woodbine were deposited near the mouths of rivers draining lowlands.

Shuler and Millican (1932) described shallow-marine, offshore, lenticular sand bodies from the Lewisville Beds of south-central Denton County. Adkins (1933), on the basis of fossil evidence, stated that the basal clay is marine and that the Dexter Sands above are, for the most part, nonmarine. His basis for this was the presence of plant fossils and few, if any, marine fossils in the Dexter Sands. He interpreted the Lewisville Beds as near-shore, marine, or brackish deposits.

Bergquist (1949) described fossiliferous, glauconitic, brown clay at the base of the Dexter Member. This is his post-Grayson, unnamed shale and sandy clay unit, which this writer believes to be equivalent to Taff's (1893) Basal Clays. This unit has been previously designated the "Rush Creek Member" of the Woodbine by the writer. From Bergquist's fossil suite, one can assume that the Rush Creek Member was deposited in a shallow marine environment.

Bergquist's Dexter Member is termed nonmarine, and his combined Red Branch-Lewisville Members, designated "Lewisville Member" by this writer, have a nonmarine to marine aspect, based on faunal remains. The Templeton Member is marine on faunal evidence given by Bergquist.

Stephenson (1952) stated that the Woodbine Formation, as originally defined, is made up of fresh, brackish, and very shallow marine water deposits. He believed that the Dexter Sands grade south and east from predominantly nonmarine flood-plain deposits to interbedded marine and nonmarine sediments. Stephenson used the term "Euless Member" as the equivalent of this writer's lower Lewisville Member. The Euless, combined with the Red River area Red Branch Member and the Lewisville Member, was described by Stephenson as being fresh to brackish to shallow marine water deposits. He accepted Bergquist's marine interpretation for the Templeton Member.

Dodge (1952, p. 77) stated:

> The Woodbine deposits of the Arlington area appear to record a struggle between the effects of sedimentation tending to extend a deltaic shoreline out to sea and the effects of subsidence tending to bring the sea back over the mainland. The lower sand [Dexter Member] may represent a local maximum in the outbuilding and intergrowth of deltaic bodies. The upper clay [Lewisville Member], with its abundant lignite and incipient soil zones, probably represents lagoonal and swampy deposits and may record stages in the subsidence of these deltas. With continual sinking of the land, the strand line moved back westward over the Arlington area and the upper sand [Arlington Member], with its ammonites and oysters, was laid down.

He interpreted his basal clay, or Rush Creek Member, as representing, at least in part, the reworked debris on the post-Comanche erosional surface.

Cotera (1956) studied the subsurface Woodbine Formation of the East Texas Basin. Most of his data came from well cores in what he designated "typical Lewisville sand." On the basis of sedimentological data, he postulated a beach or near-shore environment of deposition in a transgressive sea. This study covered the eastern part of the East Texas Basin, about 150 miles east of the outcrop of the Woodbine.

Lee (1958), working in Hill County, stated that his Dexter Formation represented sedimentation in the near-shore to offshore marine environments. It is suggested that his Lewisville Formation was formed by sedimentation along a low coastline subject to minor transgressions and regressions.

Beall (1964a) did his work to the south of where Lee studied the strata. He postulated that the Woodbine was transgressive over the post-Comanche erosional surface and believed the lower Woodbine (Dexter Member) to be a shallow marine blanket sand. The upper part, or Lewisville Member, may have been deposited in brackish water as mudflat or shallow lagoonal deposits, with some near-shore sand bars.

Dodge (1965) described an offshore bar from the lower Lewisville Member. This sand body truncates and rests in part on brown, lignitic shale of probable swamp or marsh origin. Dodge, Robertson, and Howard

(1966) described a wave-cut bench and a wave-built terrace from the upper part of the Lewisville Member in the city of Arlington, Tarrant County, Texas.

In Tercier's (1940) original definition of the paralic environment, he stated that the type of sedimentation was fundamentally alluvial; however, Krumbein and Sloss (1963) redefined the term to include not only alluvial deposits, but also lagoonal, littoral, and shallow neritic environments. From the above review of the ideas of various investigators of the Woodbine Formation, one may assume that Woodbine sediments represent an excellent example of the paralic environment.

Almost all investigators of the Woodbine have noted one thing in common, the lenticular nature of the sand bodies. This phenomenon is perhaps better developed in the Lewisville Member than in any other member.

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WOODBINE-EAGLE FORD TRANSITION, TARRANT MEMBER

by

J. Dan Powell

Abstract

The Tarrant Member of the Eagle Ford Formation is a valid, mappable rock-stratigraphic unit in northeastern Tarrant County, Texas. It represents sediments deposited in a near-shore marine environment and is a part of the overall early Gulfian marine transgression in North Texas. The member is wholly contained within the range zone of Acanthoceras wintoni Adkins.

The Tarrant Member, as mapped in this area, is included in a sequence of beds that represent the marine phase of the transition from non-marine and paralic Woodbine environments to younger offshore marine Eagle Ford environments. Petrographic studies indicate that the member, though mapped with the Eagle Ford Formation, is genetically more closely related to the Woodbine Formation and represents a complex tongue of the Woodbine lithosome.

Introduction

Beds transitional between the Woodbine Formation and the overlying Eagle Ford Formation in Tarrant County were described by Moreman (in Adkins, 1933, p. 425) as the Tarrant sandy clay and limestone. A few years later Moreman (1942, p. 195) referred to these beds as the Tarrant "formation." The Tarrant represents a more or less gradual change from paralic to offshore marine depositional environments. Upper Woodbine and lower Eagle Ford rocks are part of a transgressive phase of the early Gulfian sedimentary cycles in North Texas. The present boundary between the two

formations is a definite contact and is nearly always selected at the top of the youngest ferruginous sandstone with Crassostrea soleniscus (Meek). However, the sharply defined contact is not taken to indicate a significant hiatus.

The rocks observed at Locality 60 (Stop 4 of Field trip) crop out along a line from northeastern Arlington through the western boundary of the Great Southwest International Airport, and on northward to Grapevine in northeastern Tarrant County (Fig. 1). In the area south of the airport and along the Chicago, Rock Island and Pacific railroad tracks the transitional beds form the type section of the Tarrant formation of Moreman. This is also the area known as "Dorothy Switch" or "Dorothy Siding" (Stephenson, 1953). This section yielded most of the numerous Tarrant fossils identified by Stephenson (1953), but is now poorly exposed and is not easily studied.

Previous investigators of these strata have been mainly concerned with the fossils and unfortunately have sometimes made their nomenclatural assignments primarily on a paleontological basis. Published results of more detailed lithostratigraphic studies of these rocks are not known at this writing. Adkins (1933, p. 424-433), Stephenson (1953, p. 13), and recently Norton (1965, p. 50-63) have discussed the geological results of investigations in North Texas which have generally considered the Woodbine and lower Eagle Ford rocks in this area. In the preceding section of this Guidebook, Dodge also discussed the history of nomenclature of the Woodbine. The beds representing the Woodbine-Eagle Ford transition have in part been referred to the Tarrant "formation," or "member," of the Eagle Ford by both Moreman and Adkins (1933, p. 425). A complete review of the history of the usage of the term "Tarrant" is in Norton (Op. cit., p. 50-55).

Stratigraphy

General statement.--The Tarrant was considered by Moreman to be the basal unit of the Eagle Ford at a point two to two and one-half miles [sic]

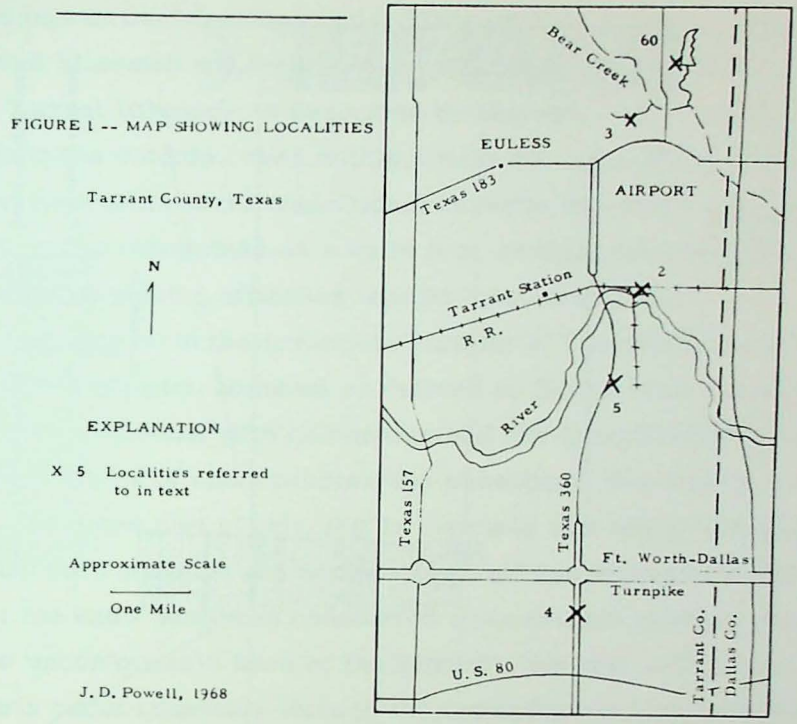


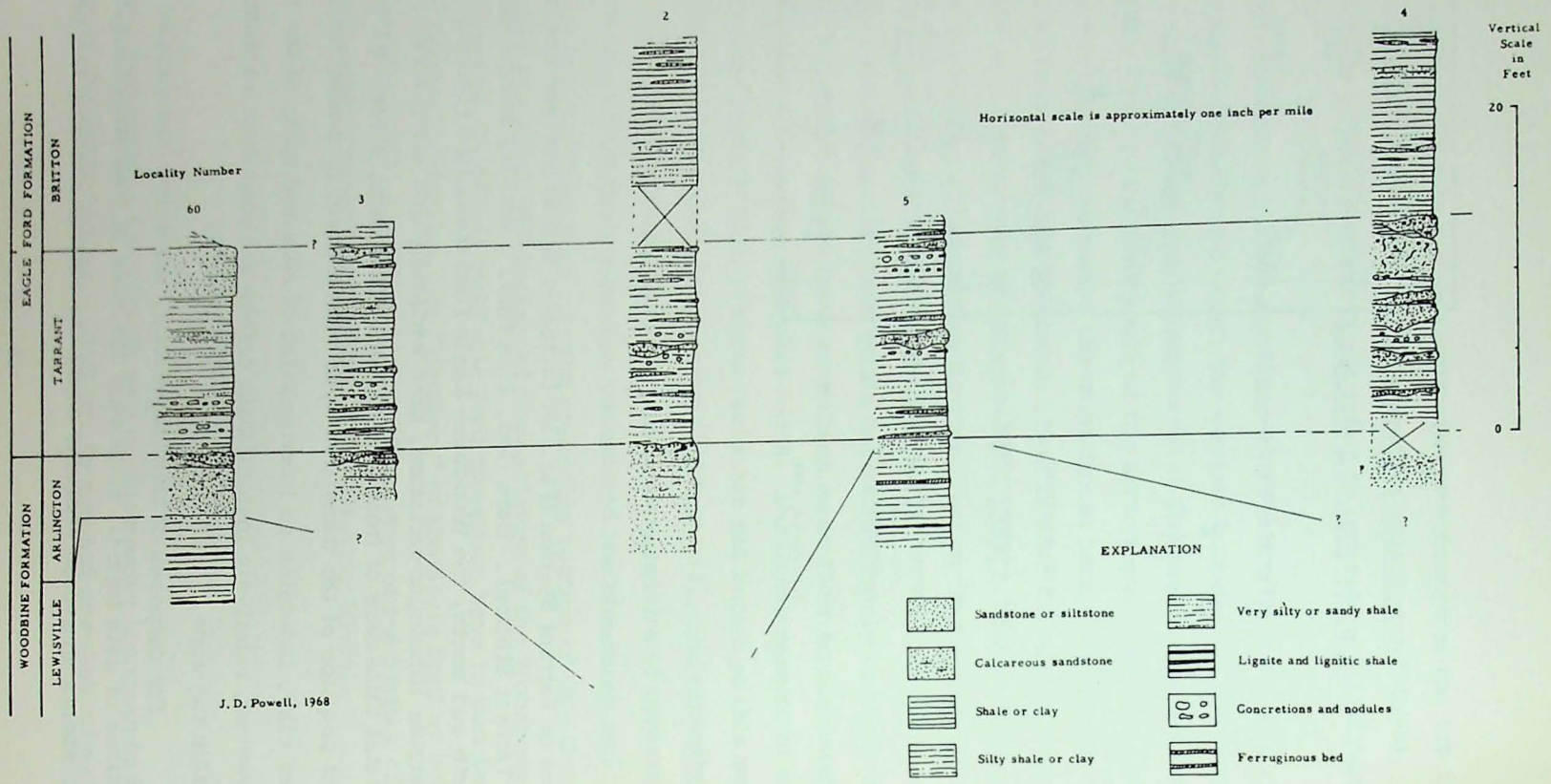
FIGURE 1 -- MAP SHOWING LOCALITIES

Tarrant County, Texas

east of Tarrant Station (Fig. 1); (actually one to one and one-half miles east of Tarrant Station). Here (loc. 2 on figs. 1 and 2), and in adjacent areas north and south, the Woodbine-Eagle Ford transition (Tarrant) is marked by complex lithologic variation, both vertically and along strike, spanning a stratal thickness of from 4 to 20 feet. This fact, along with the inconsistent position of the transition zone with respect to marker beds in the Eagle Ford clay, indicates an intertonguing of adjacent units of the two formations. However, relatively insignificant breaks in deposition undoubtedly occur within the zone.

For purposes of this Guidebook, the writer has mapped (with contributions of data from C. F. Dodge) the zone of transition (Fig. 1). Figure 2 represents measured sections along the outcrop showing the position and

FIGURE 2 -- CORRELATION OF MEASURED SURFACE SECTIONS



gross lithology of the transition beds. This unit as described here includes the beds that Moreman and others have included in the Tarrant "formation." However, Tarrant lithology as described by Moreman is not everywhere present along the outcrop, even within a mile and one-half of its type area. The Tarrant represents rocks transitional between Woodbine and Eagle Ford lithologies and is recognized as a valid rock stratigraphic unit of member status. Its stratigraphic affinities will be discussed later.

Lithologies.--In the immediate vicinity of Locality 60, the uppermost Woodbine unit (Arlington Member) as defined by Dodge (this Guidebook) is a fine quartzose sandstone with calcareous and ferruginous cement, containing local concentrations of chert pebbles and phosphatic material (see measured section). The upper part of this unit is burrowed and has an irregular surface. Phosphatic granules are common in small concentrations in the upper two feet of the bed. Moreman considered a phosphatic pebble conglomerate to mark the unconformable base of the Tarrant. Several such beds of phosphatic debris occur commonly through the upper few feet of the Arlington Member of the Woodbine and more rarely in the transition beds above. The Arlington Sandstone Member is about three feet thick here, but less than three miles south, near State Highway 360, the member is 20 feet thick, and one mile farther south the sandstone unit is absent (Fig. 2).

The Tarrant Member includes clay and interbedded slabby calcareous quartz siltstone and very fine to fine sandstone beds that are yellowish gray and reddish brown. A hundred-grain count from a thin section of one of the siltstone beds at Locality 5 (Fig. 1) showed the following constituents:

Quartz (in percent of the terrigenous fraction)	
common and vein types	90%
metaquartz	8%
Calcite (in percent of the whole rock)	
sparry cement	18%

Trace amounts of feldspar, leucoxene, and chert were also noted. The grain-size range is from 3 to 4.5 phi units. A similar count from the Arlington Member of the Woodbine at Locality 3 (Fig. 1) revealed the

following constituents:

Quartz (in percent of the terrigenous fraction)	
common and vein types	82%
metaquartz and metamorphic rock fragments	8%
chert	5%
K feldspar	4%
Calcite (in percent of whole rock)	
sparry cement	22%

Hematite, magnetite, and leucoxene were also detected in trace amounts. Dodge (personal communication) stated that channel sandstones in the Lewisville Member of the Woodbine commonly contain 40 to 50 percent feldspar. The average grain size of the quartz in the sample above is in the 2.5 to 3.0 phi unit range.

Many of the sandstones and siltstones of the Tarrant are cross-bedded and contain ripple marks. Indicated current directions for the sandstones are commonly toward the south but range through more than 140 degrees of azimuth. Sole marks and burrows are common in all of the siltstone beds.

The clay beds in the Tarrant Member are silty and contain streaks of concentrated limonite and sulfates (gypsum, jarosite, etc.). In the lower part of the member the clay is yellowish brown to light brownish orange and is interbedded with the slabby sandstones, whereas in the upper part the clay is more commonly bluish gray and more gypsiferous. Beds of the latter nature are difficult to distinguish from some similar beds in the Lewisville Member. This fact tends to support Stephenson's (1953, p. 13) view that the Tarrant is actually part of the Lewisville. However, gypsiferous bluish clays are common in the overlying Eagle Ford. Argillaceous limestone concretions are pinkish gray when fresh and become yellowish brown when weathered. They seem to represent concentrations of calcareous matter that collected and solidified before compaction of the clays.

Paleontology.--Stephenson (1953) believed the Tarrant to be a part of the Lewisville (Op. cit., p. 14) and thus included the Tarrant fauna in

in his study of the Woodbine invertebrates. Indeed, his illustrations and fauna lists do cover virtually all of the invertebrates found in the Tarrant by the present writer. The following fossils have been identified from the Tarrant Member from localities 2, 3, 4, 5, and 60:

Ammonites

Acanthoceras wintoni Adkins

Acanthoceras tarrantense (Adkins)

Epengonoceras dumbli (Cragin)

Turrilites dearingi Stephenson

Forbesiceras conlini Stephenson

Scaphopod

Dentalium sp.

Bivalves

Ostrea subradiata Cragin

Ostrea sp. cf. *O. leveretti* Stephenson

Crassostrea soleniscus (Meek)

Exogyra columbella Meek

Phelopteria dalli (Stephenson)

Phelopteria sp. cf. *P. dalli* (Stephenson)

Psilomya sp.

Priscomactra cymba Stephenson

Cymbophora sp.

Nuculana sp.

Brachidontes spp.

Brachiopod

Lingula subspatulata Hall and Meek

Gastropods

Turritella shuleri Stephenson

Gyrodes tramitensis (Cragin)

Euspira sp.

Foraminifers

Ammobaculites coprolithiformis (Schwager)

Trochammina spp.

No biostratigraphic discontinuity is indicated by the ammonite zonation across the Woodbine-Eagle Ford boundary. The thick sandstones of the Arlington Member commonly contain specimens of Acanthoceras wintoni. Below this member several poorly preserved specimens of Acanthoceras are also comparable to the fauna described by Adkins (1928) from the Tarrant at "Dorothy Switch." In the overlying Tarrant Member Acanthoceras wintoni is abundant at most localities. The same fossil also occurs in the lower beds of the Eagle Ford (above the Tarrant) at Locality 4. The zone of A. wintoni is thus well developed in northeastern Tarrant County and rests astride the Woodbine-Eagle Ford boundary as located by any of the previous investigators.

Depositional Environments

General statements.--Both sedimentologic and paleoecologic lines of evidence suggest that the site of deposition of the Woodbine and Woodbine-Eagle Ford transition sediments was along and just offshore of a low-lying coastal plain. The Tarrant Member is transitional both lithologically and environmentally from typical Woodbine rocks to typical Eagle Ford rocks. Thick oyster-bearing sands of the Arlington Member indicate estuarine or brackish bay conditions, with possible modification by littoral encroachment during transgression. The actual strand line between mainland (or barrier) and sea existed in this immediate area during deposition of most of the Arlington Member sediments. Occurrence of diastemic breaks in the depositional sequence and associated discontinuous thin bodies of coarser clastic sediment is to be expected under such conditions. Beds of coarser clastic sediments appear in the transition zone, but are mostly absent from the overlying Eagle Ford marine clays.

Sedimentologic evidence.--Examples of nearly all common types of cross-stratification can be observed at one place or another in the sandy beds of the Tarrant. The most common type is current-ripple cross-bedding,

which occurs in about half of the sandstones greater than 2 centimeters thick. Moderately large-scale scour and fill features are common in the thicker sandstones. Small cuspate current ripples are rare. A few oscillation ripples occur with their crests aligned in an approximately north-south orientation. Most of the current features indicate a direction of transport from north to south, but range from southeast to southwest. Numerous streaks of quartz silt and fine sand in the clays indicate significant current action throughout most of the deposition of the Tarrant.

Distribution of the sandstone beds within the overall calcareous silty clay matrix, primary sedimentary structures, pebbles and granules of phosphate chert, and smaller erosional breaks suggest deposition in near-shore areas. Not one of these separate bits of evidence necessarily indicates, in itself, shallow, near-shore environments, but paleoecologic evidence from fossils occurring in these beds all along the outcrop in Tarrant County supports such a conclusion.

Paleoecologic evidence.--Several groups of invertebrates occurring in the Tarrant beds indicate open bay or similar near-shore conditions during deposition. Linguloid brachiopods and groups of oysters are commonly referred to environments with some brackish water influence. Ammonites, turritellid and naticid snails, scaphopods, and pteriid clams clearly show marine conditions. Arenaceous foraminifers are abundant, whereas calcareous planktonic genera are significantly absent. Abundant evidence of burrowing animals and plant fragments also indicate near-shore condition of deposition. Generally decreasing abundance of plant debris and increase in organically derived calcite (in chalky clay) immediately above the transition beds indicate a lessening of near-shore influence.

Conclusions

The Tarrant Member of the Eagle Ford is a thin, mappable, but locally restricted, rock-stratigraphic unit in northeastern Tarrant County.

It represents the transition between the Woodbine Formation and the overlying Eagle Ford Formation. Genetically the coarser detritus of the Tarrant most closely resembles that of the Lewisville and Arlington members of the Woodbine. Moreman's original definition of the Tarrant as a unit is accepted by the writer with reservations about his reported thickness of up to 50 feet. However, the unit should be of no greater rank than member. Until more information is gathered from the subsurface and from surface exposures in Denton County, the Tarrant can be mapped with equal credibility as a member of the Woodbine or Eagle Ford formations.

Evidence from lithology, paleontology and lithostratigraphy indicates a marginal marine environment of deposition for Tarrant sediments. The earlier beds of the member resemble the Woodbine and the later beds more closely resemble the overlying Eagle Ford.

Figure 2 represents rocks at localities situated at a small angle to original depositional strike in this area. An embayed coastline with areas of little current activity both at the strand line and somewhat offshore could account for the local absence of many sandy beds at some localities in the overall transitional sequence.

The Tarrant represents a part of the overall transgression which began during Woodbine deposition and continued during accumulation of lower Eagle Ford sediments.

From a practical viewpoint, the Tarrant Member is more easily mapped with the Eagle Ford Formation, but any study of the Woodbine lithosome as a genetic unit should include Tarrant beds.

Measured Sections

Locality 2

Section of upper Arlington Member of Woodbine and Tarrant Member and lower Britton Member of the Eagle Ford, measured about 400 yards east of Dorothy Siding and 100 yards south of the Chicago, Rock Island and

Pacific R. R. tracks, in a small gully. This section is just south of Greater Southwest International Airport, Tarrant County, Texas.

Eagle Ford Formation

Britton Member — Feet

Shale: dark-gray weathering bluish-gray, silty, jarositis; contains a few very thin (1 inch) discontinuous beds of brownish-gray calcareous siltstone and silty calcarenite; lower 4 feet covered. — 13

Tarrant Member (Type locality)

Clay and interbedded sandstone flags: clay, light yellowish-brown, silty, with Lingula subspatulata. Sandstone flags: grayish-brown; very fine quartzose, silty, calcareous cement; finely laminated, irregular thickness (1-6 inches). Unit contains calcareous nodules. Fossils in flagstones: Epengonoceras dumbli, Priscomactra cymba, Phelopteria dalli, Psilomya? sp., Botula? sp., Turritella shuleri, Gyrodes tramitensis, Exogyra columbella. — 12

Woodbine Formation

Arlington Member

Sandstone: reddish- and yellowish-brown, fine, quartzose, calcareous cement; contains phosphatic pebbles and granules, fish teeth, sponge-bored oysters; burrowed, irregular upper surface. Lower few feet as above but soft, friable, and without phosphate and teeth; contains Protarca tramitensis, Brachidontes spp., Crassastrea soleniscus, some in living position. Base not exposed. — 8

Total section measured — 33

Locality 3

Section of upper Arlington Member and Tarrant Member, 200 yards upstream from bridge over tributary to Bear Creek on Woodland Hill Farm (Herman Dearing place); and 1/4 mile north of Texas Highway 183, northeast of airport.

Eagle Ford Formation

Tarrant Member — Feet

Sandstone: yellowish- and reddish-brown, fine, quartzose, limonitic, locally with phosphatic granules and elasmobranch teeth; burrowed. 0.5

Clay: yellowish-brown, sandy, gypsiferous, with small fragments of lignite; 4 in.-thick, very fine calcitic quartz sandstone at base. 3.5

Sandy shale: gray becoming yellowish-brown below, with concretions and lenses of yellowish-brown, sandy limestone containing Turritella shuleri, Crassostrea soleniscus, Ostrea subradiata, Phelopteria dalli, Exogyra columbella, Acanthoceras wintoni, A. tarrantense, Expengonoceras dumbli, Turrilites dearingi, Forbesiceras conlini. 6.0

Shale and sandy flags: shale, gray to yellowish-brown, carbonaceous, locally glauconitic and phosphatic. Sandy flags, 1 to 3 inches thick, grayish-brown, calcitic, fine, quartzose, locally glauconitic and phosphatic, contains oysters. 3.0

Woodbine Formation

Sandstone: rusty-brown, fine, quartzose, calcitic, cross-laminated; base not exposed. 3.0

Total section measured 16.0

Locality 4

Section of Tarrant Member and lower part of Britton Member of the Eagle Ford Formation; exposed in drainage ditch between north and southbound lanes of Texas Highway 360, between Randol Mill Road and Dallas-Fort Worth Turnpike and Six Flags Park, Northeast Arlington.

Eagle Ford Formation

Britton Member — Feet

Clay: dark-gray weathering pale grayish-orange, calcareous, hard and rather brittle when dry, bentonitic; contains thin, discontinuous lenses of qtz. siltite and calcsiltite along with streaks

	Feet
and beds of white to orange bentonite up to 8 inches thick.	18
Sandy flags: reddish-brown quartz-bearing calcarenite, calcite cement, locally hard and resistant, 1 inch to 3 inches thick; contains fish debris, mainly Ptychodus whipplei, lamnid shark and teleost fragments; lucinid clams, Inoceramus pictus, Acanthoceras cf. A. wintoni impressions, Eucalycoceras? sp. and Tarrantoceras? impressions. Calcareous clay as above.	1
Silty clay and flags: Silty clay, light olive-gray to dark-gray, non-calcareous, with silt laminae and tuffaceous? sand. Flags, quartz-bearing, reddish-brown calcsiltite as above, occuring in top 3 feet of unit.	7
Sandy clay: light to dark bluish-gray, silty streaks, mottled and streaked with limonite stain and jarosite; top of unit is 1 to 4 inches tuffaceous? sandstone, with feldspar and mica. Base of unit is soft, clayey quartz sand.	5
Tarrant Member	
Sandstone: yellowish- and grayish-brown, very fine to fine quartzose, with few chert pebbles and locally abundant phosphatic granules; burrowed, local calcareous cement; grades downward into gray to yellowish-brown gypsiferous sandy clay (2 feet).	4.5
Sandstone: yellowish-gray to brown, very fine quartzose, with large crustacean burrows (Callianassa?), Acanthoceras wintoni, Eucalycoceras sp., tellinid clams; contains wave ripples trending N-S, and current cross-laminations.	2
Sandstone and shale: sandstone, yellowish-brown, very fine to fine quartzose, in beds ranging in thickness from 3 to 8 inches. Shale, bluish-gray and yellowish-gray, silty with calcareous quartz siltstone flags 1 to 3 inches thick. Shale and sandstone complexly interbedded and contain A. wintoni, A. tarrantense, Epengonoceras dumbli, Phelopteria dalli, Exogyra	

	Feet
columbella, Ostrea subradiata, mactrid and other clams. Base of Tarrant not exposed.	6
Total section measured	43.5

Locality 5

Section of Lewisville Member of Woodbine and Tarrant Member of Eagle Ford, measured in roadcut on east side of Texas Highway 360, 1.2 miles south of bridge over Trinity River and 1.9 miles due south of terminal at Great Southwest International Airport, Tarrant County.

Eagle Ford Formation

Tarrant Member	Feet
Shale: yellowish-brown, silty, with thin (1 inch) calcareous siltstone flags, poorly exposed. Shale, brown to yellowish-brown, silty with interbedded olive-gray to yellowish-brown very fine clayey quartz sandstone with calcite cement, contains Exogyra columbella, Ostrea subradiata, Priscomactra sp., Phelopteria dalli, corbulids, naticid snails; also with calcareous nodules as at Locality 60; contain Borrisiakoceras compressum, Epengonoceras dumbli, Acanthoceras wintoni, A. tarrantense.	6
Sandstone and clay: sandstone, light yellowish-brown, muddy, very fine to fine, quartzose, thin, 2 to 6 inches, slabby, same fossils as above; calcareous nodules and septaria associated with some beds, contain well-preserved nuculanids, naticids, and scaphopods. Clay, yellowish-brown, silty.	6.5
Sandstone: light grayish- and yellowish-brown, calcareous, locally contains abundant Exogyra columbella.	0.1
Lewisville Member	
Shale: dark brownish-gray, fissile, sandy, gypsiferous, with E. columbella.	3.0
Ferruginous bed: dark reddish-brown sideritic clayey sandstone, with burrowing clams and an ovate form of Crassostrea soleniscus.	0.1

	Feet
Shale: gray, silty, gypsiferous, carbonaceous, with snails, clams, and abundant ovate Crassostrea soleniscus, many with shells bored by Cliona and Lithophagus. Unit also contains lignitic zones, jarosite, thin sandstone beds 1 to 2 inches (usually ferruginous). Base not exposed at north end of roadcut.	35.0
Total section measured	

Locality 60

Section of upper Lewisville Member and Arlington Member of Woodbine and Tarrant Member of Eagle Ford; measured in east-facing bluff at spillway of small lake on the Moroney Farm, just east of Trigg Road, one and one-half miles north of Texas Highway 183, Tarrant County.

Eagle Ford Formation

Tarrant Member	Feet
Sandstone: yellowish- to reddish-brown, fine quartz sand, calcareous cement, hard prominent, bedded, with a few oyster fragments.	3.2
Claystone and shale: pale brownish-orange, silty, blocky fracture, with streaks of quartz silt and sand. Also includes a 1- to 5-inch thick concretionary bed, hard calcareous, sandy, with Ostrea subradiata, O. cf. O. leveretti.	7.4
Siltstone: yellowish-brown, calcareous, prominent thinly laminated, with oyster fragments.	0.1
Claystone: medium brownish-orange, silty, with a few 3- to 8-inch calcareous nodules which are pinkish gray and yellowish brown, containing Acanthoceras wintoni, Epengonoceras dumbli.	2.0
Sand: soft, reddish-brown, clayey, hematitic, with phosphatic and sideritic granules and pebbles.	0.3

Woodbine Formation

Arlington Member

Sandstone: rusty-brown, fine, quartzose, chert-bearing; moderate sorting, calcitic, hematitic, contains chert, siderite and phosphate pebbles

	Feet
and granules, attached Crassostrea solenisus, A. wintoni, bone fragments and teeth. Current ripples with crests oriented approximately E-W preserved in protected lows in irregular upper surface.	1.0
Sandstone: as above but with festoon cross-bedding and lesser amounts of phosphate, siderite, and calcareous cement.	3.0
Lewisville Member	
Shale: various shades of gray, carbonaceous, silty, fissile, gypsiferous, with some mottling of light-gray quartz sand in lignitic shale, and yellowish jarosite streaks.	5.6
Shale: purplish- and yellowish-gray, silty, with jarosite mottles and light-gray silt streaks; weathers flaky; grades upward into black, carbonaceous shale.	3.0
Shale: dark-gray, carbonaceous, silty, gypsiferous, jarositic; grades upward into bluish-gray, clayey quartz silt. Base not exposed.	3.5
Total section measured	29.1

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ROUTE LOG

G.S.A. Field Trip

Introduction

This Field Trip is arranged so as to examine the members of the Woodbine Formation in ascending order, beginning with the basal contact (Comanche-Gulf Series) and proceeding through the controversial Tarrant flags into the overlying Eagle Ford Formation.

The road log includes four localities ("Stops"), and each includes one to three sites. The route and localities are shown on the General Locality Map (Fig. 1). The location of each site is shown on a General Site Map at the beginning of the discussion of each locality (see Table of Contents).

The discussion of each locality and its sites has been placed together in this Guidebook (see Table of Contents). The road log is reduced, therefore, to a set of route instructions, which begin below:

Locality 1 - The emergency spillway cut on the northeast shore of Lake Arlington, 5.5 miles west of the city of Arlington, Texas.

Site A - The Grayson Marl, locally the uppermost unit of the Comanche Series, is well exposed along the lake shore. The contact between the Gulfian Woodbine Formation and the underlying Grayson Marl can be seen at the base of the south wall of the spillway cut, about 100 yards east of the lake shore. For a discussion of the basal conglomerate at this site, see Locality 1 - Site A.

Site B - A complete section of the Rush Creek Member, lowermost unit of the Woodbine Formation in Tarrant County, is exposed at the west end of the north wall of the spillway

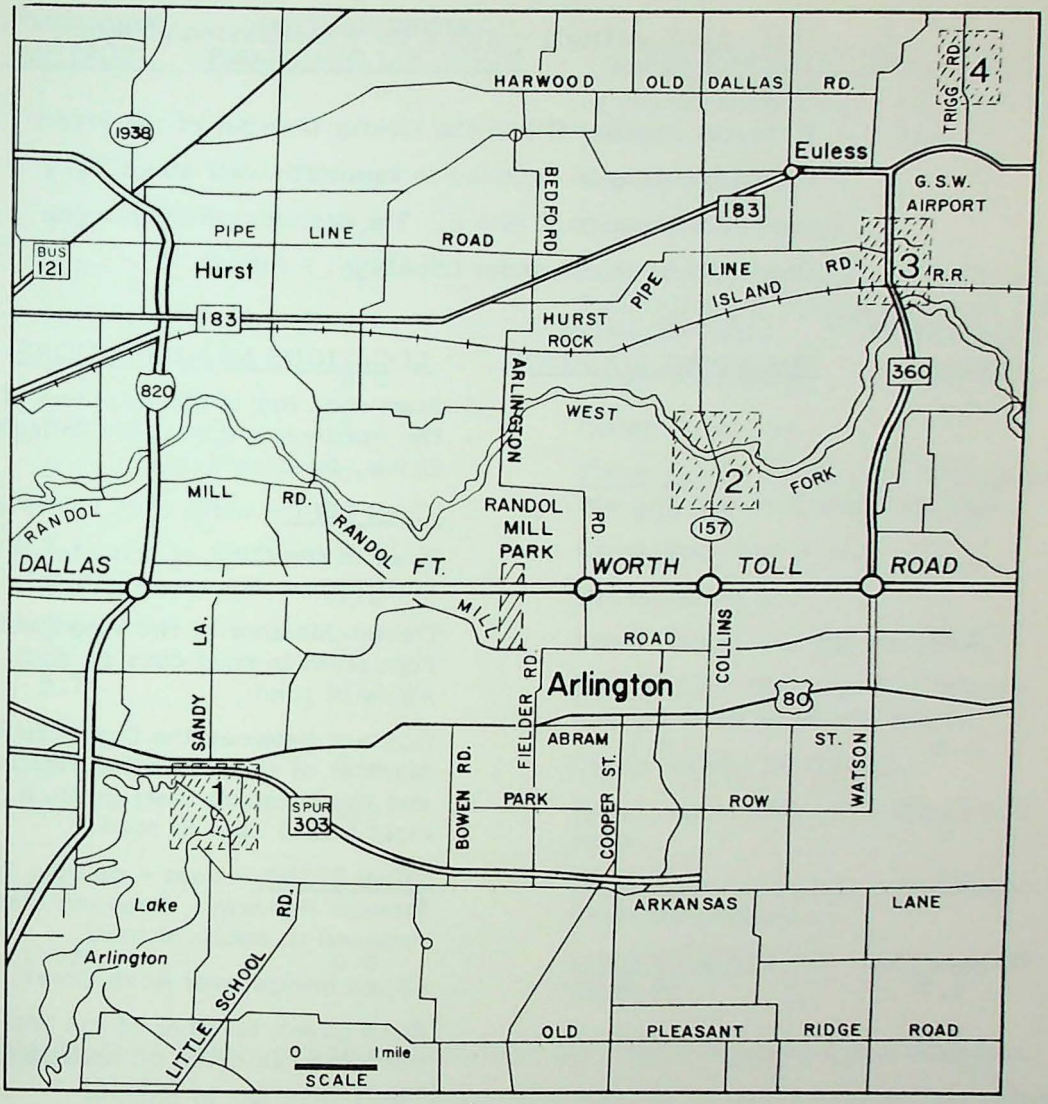


Figure 1.-- Map showing Field Trip localities.

cut. See Locality 1 - Site B for a discussion of this outcrop.

Site C - A fluvial channel fill in the Dexter Member of the Woodbine Formation is exposed in the north wall about 200 yards to the east of Site B. The discussion of this outcrop will be found under Locality 1 - Site C.

CUMULATIVE MILEAGE	MILEAGE FROM PRECEDING LOCATION	LOCATIONS AND DIRECTIONS
0.0		Start road log at the east end of the spillway cut on Lake Arlington Drive, heading east.
0.3	0.3	TURN LEFT - north - on Lakewood Dr.
0.6	0.3	Road to the City of Arlington Water Purification Plant on right.
0.9	0.3	Dexter Member of the Woodbine Formation in road cuts on both sides of road.
1.0	0.1	Contact between the Rush Creek Member of the Woodbine Formation and the Grayson Marl in ditch on right (east) side of road.
1.1	0.1	TURN RIGHT - east - on Spur 303, Pioneer Parkway. Grayson Marl exposed to south of road.
1.7	0.6	Cross bridge over Rush Creek.
2.0	0.3	Rush Creek Member of the Woodbine Formation in ditch on both sides of road.
2.1	0.1	Contact between Dexter and Rush Creek Members of the Woodbine Formation on south side of road in bar ditch.
3.0	0.9	Offshore sand bar in Lewisville Member of the Woodbine Formation. For a detailed description of this Locality, see Dodge (1965).
3.4	0.4	Cross Bowen Road.
3.6	0.2	Cuesta formed by Arlington Member

CUMULATIVE MILEAGE	MILEAGE FROM PRECEDING LOCATION	LOCATIONS AND DIRECTIONS
		of the Woodbine Formation on skyline.
4.3	0.7	Top of cuesta.
4.4	0.1	Cross Fielder Road.
4.8	0.4	Administration Building for Arlington Public School System on north side of road.
5.4	0.6	Cross Cooper St.
5.9	0.3	Cross Center St.
6.5	0.6	TURN LEFT - north - on Collins St. We are now on Eagle Ford shale.
7.4	0.9	Cross Park Row Ave.
8.4	1.0	Cross Abram St.
8.5	0.1	Cross Texas-Pacific Railroad.
8.7	0.2	Cross U.S. Highway 80. We are now on Farm Road 157 North.
9.5	0.8	Cross Randol Mill Road.
10.1	0.6	Cross over Dallas-Ft. Worth Toll Road.
11.1	1.0	Begin descent of hill onto Trinity River flood plain.
11.7	0.6	TURN RIGHT on dirt road; park off highway.

Locality 2 - A nearly complete section of the Dexter Member and a complete section of the overlying Lewisville Member of the Woodbine Formation can be seen in the road cuts along Farm Road 157, south of the Trinity River.

Site A - The Dexter Member of the Woodbine Formation is exposed in the Trinity River Channel and in road cuts on the lower portion of the hill. For a discussion of this outcrop, see Locality 2 - Site A.

WALK SOUTH ON FARM ROAD 157

Site B - The contact between the Lewisville Member of the Woodbine Formation and the underlying Dexter Member is exposed in road cuts on both sides of Farm Road 157, just to the north of the old red sandstone farm house, 0.6 miles south of the Trinity River bridge. A discussion of the Lewisville Member will be found under Locality 2 - Site B.

RETURN TO CAR; TURN AROUND AND DRIVE SOUTH ON FARM ROAD 157.

CUMULATIVE MILEAGE	MILEAGE FROM PRECEDING LOCATION	LOCATIONS AND DIRECTIONS
13.9	2.2	Pass over Toll Road.
14.6	0.7	TURN RIGHT - west - on Randol Mill Road; go 2.6 miles to Randol Mill Park; turn right (north) for 0.1 miles; turn left (west) into parking lot for LUNCH STOP.
		RETURN to Randol Mill Road.
		TURN LEFT - east - and pick up road log at intersection of Randol Mill Road and Farm Road 157.
0.0		Intersection of Randol Mill Road and Farm Road 157. Go east on Randol Mill Road.
0.5	0.5	Entrance to Turnpike Stadium on Left.
1.0	0.5	Six Flags over Texas Road on Left.
2.0	1.0	Eagle Ford shale on both sides of road.
2.2	0.2	TURN LEFT - north - on State Highway 360.
2.5	0.2	Tarrant in ditch on west side of road.
2.9	0.4	Cross over Toll Road.
3.6	0.7	Arlington Member of Woodbine Formation in road cut on west side of road.

CUMULATIVE MILEAGE	MILEAGE FROM PRECEDING LOCATION	LOCATIONS AND DIRECTIONS
3.7	0.1	Quaternary Terrace.
5.8	2.1	Tarrant overlying Lewisville Member of the Woodbine Formation in road cuts on both sides of road.
6.8	1.0	Cross Trinity River.
7.2	0.4	STOP. Park on shoulder off left side of road, under the railroad bridge.

Locality 3

Site A - The uppermost Lewisville Member and the Arlington Member are exposed in road cuts on both sides of the road. For a discussion of this outcrop, see Locality 3 - Site A.

RETURN TO CAR; CONTINUE NORTH ON STATE HIGHWAY 360.

7.5	0.3	TURN RIGHT - east - on airfield service road.
7.6	0.1	Lewisville-Arlington contact in ditch on left side of road.
7.7	0.1	STOP. Park on right side of road.

Locality 3

Site B - A complete section of the Arlington Member of the Woodbine Formation is exposed along the road cut. Locally, thin lenses of gravel are intercalated in the sandstone and contain fish teeth and other vertebrate remains. This outcrop is discussed under Locality 3 - Site B.

TURN AROUND AND RETURN TO STATE HIGHWAY 360.

8.0	0.3	TURN RIGHT - north - on State Highway 360.
8.9	0.9	KEEP RIGHT on State Highway 183 East.
9.1	0.2	TURN RIGHT - east - on State Highway 360. Lower Eagle Ford shale

CUMULATIVE MILEAGE	MILEAGE FROM PRECEDING LOCATION	LOCATIONS AND DIRECTIONS
		overlying Arlington Member of the Woodbine Formation in bar ditch on south side of road.
9.8	0.7	Pass under runway.
10.1	0.3	TURN LEFT - north - across State Highway 183.
10.3	0.2	Road curves back to the north.
11.0	0.7	Cross Bear Creek.
11.2	0.2	Pavement begins.
11.8	0.6	TURN RIGHT - east - through gate into the Moroney Farm. Drive to southeast past farm house.
12.1	0.3	STOP. Park along lake shore and walk down to spillway cut.

Locality 4

Site A - The uppermost Lewisville Member and the Arlington Member of the Woodbine Formation are overlain by the Tarrant Member of the Eagle Ford Formation at this locality. For a discussion of this outcrop, see Locality 4 - Site A.

END OF FIELD TRIP

LOCALITY 1

by

Charles F. Dodge

Locality 1 is in and around the emergency spillway excavation on the northeast shore of Lake Arlington, located 5 miles east of Arlington,

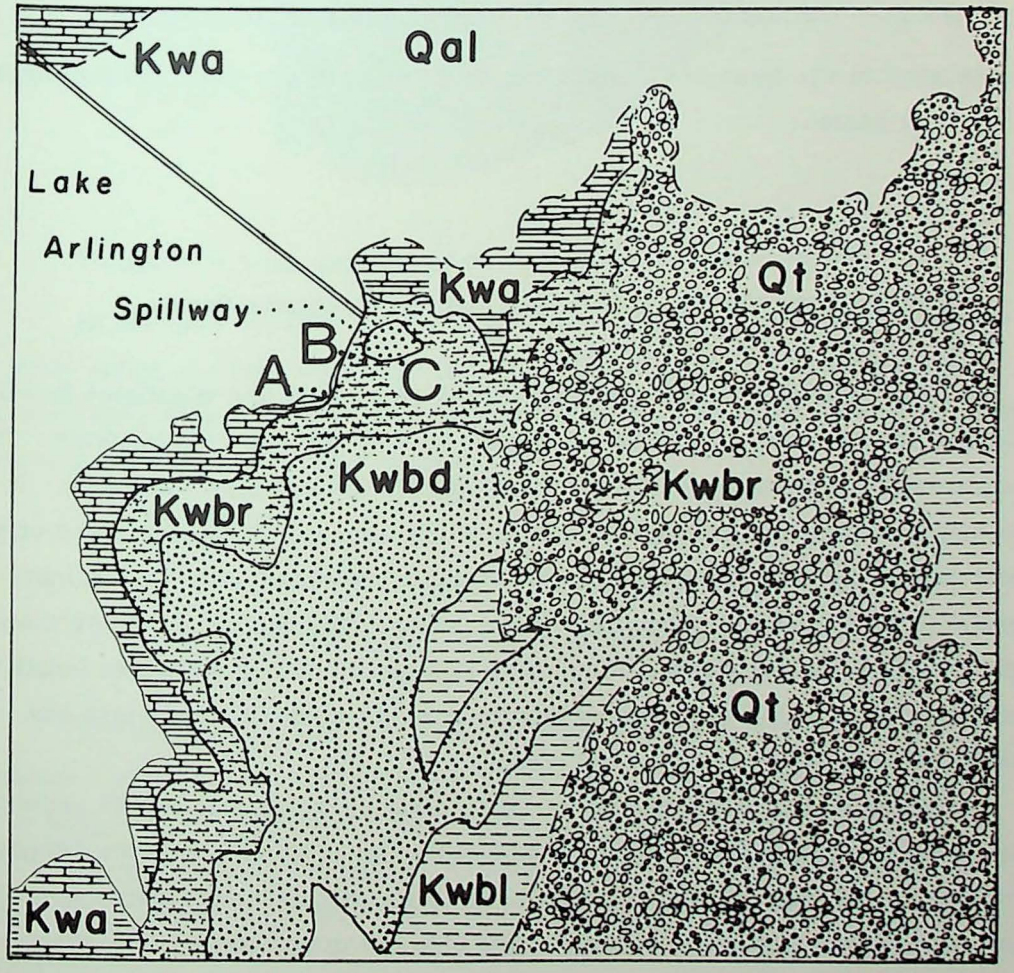


Figure 1.--Site map for Locality 1. Scale: one inch = 2,000 feet. Kwbl = Lewisville Member, Kwbd = Dexter Member, Kwbr = Rush Creek Member, Woodbine Formation; Kwa = Washita Group.

Texas. The geology of the area is shown in figure 1, and a generalized cross section of the north wall of the cut is shown in figure 2. Locations of Sites B and C are designated on both the map and the cross section. Site

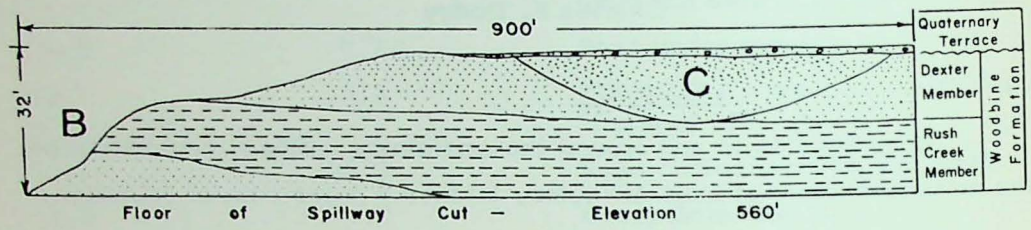


Figure 2.-- Geologic cross section of north wall of spillway cut.

A is located at the base of the south wall of the spillway cut, 400 feet east of the lake shore.

Site A

Contact Between the Gulf Series and the Comanche Series

The contact between the Rush Creek Member of the Woodbine Formation and the Grayson Formation is marked here by a basal conglomerate. The conglomerate is up to 1.5 feet thick and grades upward into sandstone. It directly overlies gray calcareous shale of the Grayson Formation. The clastic particles of the conglomerate are very heavily cemented with a ferruginous cement, giving the rock a reddish-brown color. The clastic particles themselves vary from ferruginous clay chips ranging up to two inches in length to hematitic shell fragments and vertebrate remains such as fish centra and teeth, all in a fine-grained sand matrix.

Cement and replacement hematite make up approximately 40 percent of the conglomerate in areas where it is exposed or is in contact with a Quaternary terrace gravel deposit. Where this unit is not exposed, the cementation and replacement are much reduced, and chips of gray clay are imbedded in a fine sand matrix which has a mean size of about 3.25 ϕ units.

Imbrication of clay chips in the conglomerate indicates a N 10° W current direction. Figure 3 is a photograph of a cut surface of the conglomerate, showing both the clastic particle size and the pebble imbrication.

Figure 3.--A cut surface of the conglomerate from Site A.

At the type locality for the Rush Creek Member, the basal conglomerate is about one foot thick and is made up of cobbles and boulders of Grayson marl in a very fine-grained sand matrix. The upper part of the sand contains numerous ironstone concretions.

Site B

Rush Creek Member of the Woodbine Formation

A complete section of the Rush Creek Member of the Woodbine Formation is exposed in the west end of the walls of the spillway cut at Lake Arlington. The best section for viewing is located along the north wall of the cut. At this locality the Rush Creek is made up of a basal tan sandstone measuring up to 14 feet thick and a brown to black, slightly sandy shale unit measuring up to 25 feet thick.

The sand is very fine grained, with the 22 samples analyzed having a mean grain size of slightly over 3.0 ϕ units. Sorting values for these

samples range from 0.36 to 0.51 and average 0.42. The samples are all positively skewed.

Directional parameters for this unit all indicate a northwest-southeast current flow direction. Cross-bedding dip direction is generally to the south-southeast and ranges up to 17°. The vector mean for 25 dip directions is 130°, with a variance of 6700 and a standard deviation of 82°. Ripple crests trend generally to the northeast, indicating a northwest-southwest current direction.

Grain orientation plots of ten oriented bedding plane thin sections indicate the major grain orientation trend is northwest-southeast. These grains were so elongated and angular that no end-position direction could be plotted.

Petrographically, the sandstone ranges from sub-arkose to feldspathic sub-graywacke, using Folk's (1954) classification. Common quartz plus chert ranges from 66 percent to 81 percent, metamorphic quartz from 6 percent to 13 percent, and feldspar from 8 percent to 23 percent. "Leucoxene" and magnetite are the dominant opaque heavy minerals, with zircon and tourmaline, both rounded and euhedral, making up the balance of the heavy mineral suite.

The basal sandstone unit of the Rush Creek Member seen here is not everywhere present and, where present, its thickness is quite variable. At the type locality for the Rush Creek (3,500 feet to the southeast) the sandstone is less than one foot thick. Just south of the intersection of Lakewood Drive and Spur 303 (4,000 feet to the northeast) the sandstone is also less than one foot thick.

The basal sandstone is also present in several water wells located from 1.5 to 2.0 miles to the southwest. In these wells the sandstone is up to 12 feet thick and is the local aquifer. On the west side of Lake Arlington, most of the higher hills are capped by a sandstone which directly overlies the Grayson Formation. These hilltops are badly weathered, and no complete section of the basal sand is seen. However, sandstone in excess of 15 feet in thickness is present.

The general westward thickening of this sandstone body, along with other sedimentary parameters such as sorting, skewness, and the various directional parameters, suggests a shallow marine (above wave base) environment of deposition for this sand unit.

The overlying shale portion of the Rush Creek Member is well exposed in both faces of the spillway cut. Here the shale is up to 25 feet thick and is predominantly dark gray to black fissile shale with a few very thin sand streaks and discontinuous silt stringers.

X-ray analysis of the clays present in the shale indicates that montmorillonite is the major clay mineral. Traces of both illite and kaolinite occur in some samples.

Megafossils from this unit are rare. Bone fragments and chips of carbonized wood have been found at several localities, and a thin bed of pelecypods has been found in one outcrop located about one mile south of the spillway cut.

The microfauna of the shales is also sparce; however, Dr. C. L. McNulty has identified several species from the shales. Planktonic forms such as Heterohelix sp. and Archaeoglobigerina sp. appear abraided and are calcite filled. Typical benthonic forms are Spiroloculina sp., Cibicides sp., and Valvulineria sp. The latter forms are similar in form to near-shore types found along modern coasts.

Several early investigators believed that this unit represented either clay deposited near the mouth of rivers which were draining lowlands or the bottom-set beds of a delta. Both the clay mineralogy and microfauna would support a shallow marine (below wave base) environment of deposition for this portion of the Rush Creek Member of the Woodbine Formation.

Site C

Channel Sandstone in the Dexter Member of the Woodbine Formation

This channel is cut through interbedded sandstone and shale of the lower Dexter Member and into the shale of the Rush Creek Member. The rocks composing the channel fill are white to red, friable to ferruginous cemented, cross-bedded, fine-grained sandstone. The upper surface of the exposure is covered with one to three feet of Quaternary terrace gravels. and it is not known if the full channel deposit is represented in outcrop.

The channel sand body is 320 feet across and 15 feet thick at its center. Figure 4 is a cross section of the sand body showing sample location, cross-bedding dip direction, and long-axis grain-orientation azimuth direction. The arithmetic mean for 36 measured dip directions is 176°, with a vector mean of 190°. Long-axis grain-orientation azimuth direction by the Chi^2 method is 162°-342°. The grain end position mean direction is 350°. These data all suggest a flow direction just east of south. The confidence level for the Chi^2 grain-orientation calculation was 99.5 percent.

Table 1 gives the various sedimentary statistical parameters calculated from the grain-frequency data obtained on each sample. The mean and standard deviation for all method of moment parameters is also given. As can be seen, the sands from this channel are remarkably uniform throughout. No upward decrease in grain size was noted.

Table 2 shows the mineralogical composition and rock type of 15 selected samples from this outcrop. Rock type in the channel is very uniform, with 12 of the 15 samples being arkose, 2 impure arkose, and 1 feldspathic subgraywacke. Table 3 shows number percent of heavy mineral grains (less the magnetic fraction) of six samples from this outcrop. Leucoxene and well-rounded zircon make up a majority of the heavy minerals in this channel.

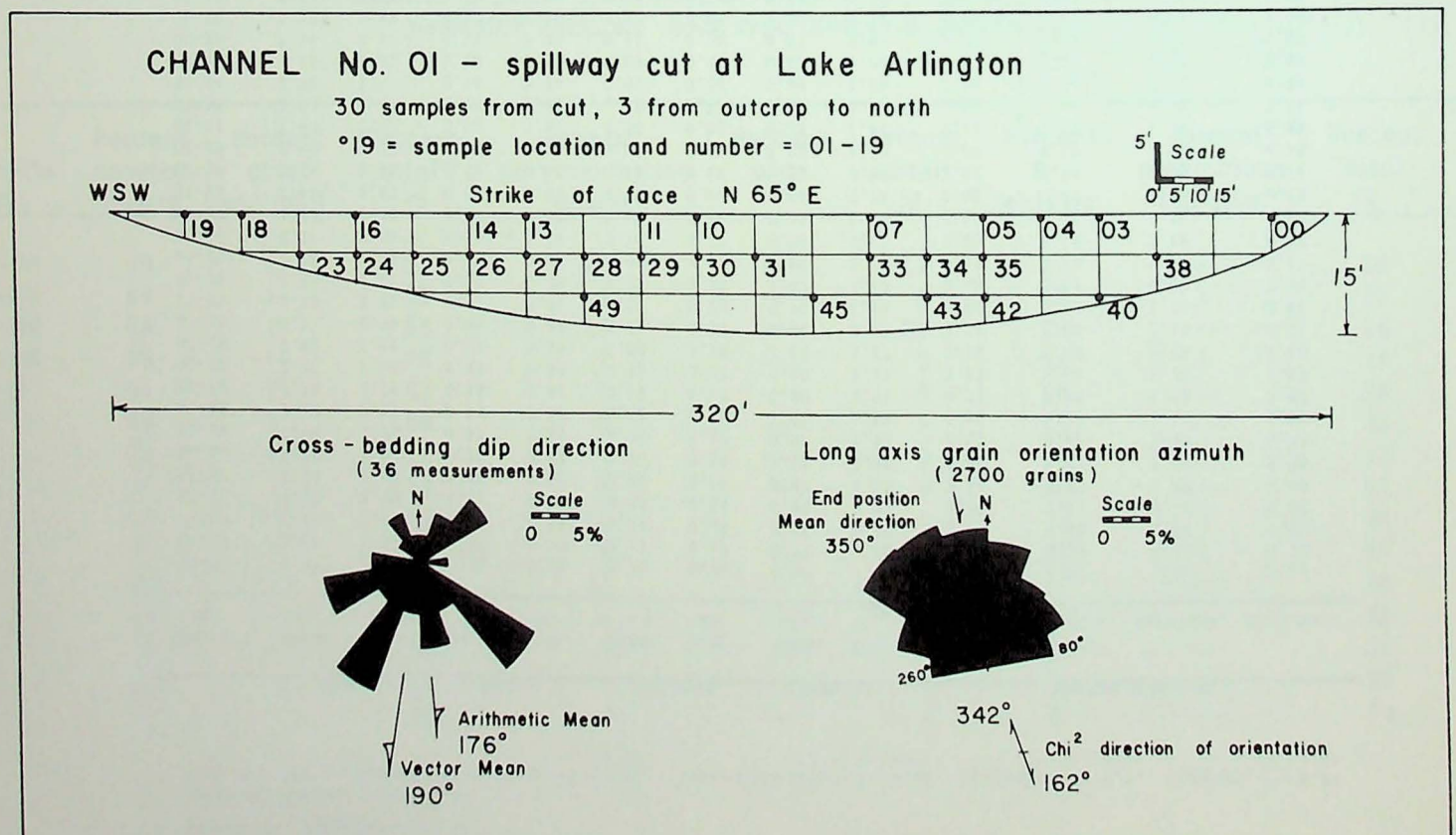


Figure 4.--Cross section scale diagram showing sample locations, cross-bedding dip direction, and long-axis grain-orientation azimuth.

TABLE 1

STATISTICAL PARAMETERS

Channel 01: Total Samples--33

Mean and Standard Deviation for Method of Moment Parameters: Mean--$\bar{X}$ = 2.49, S = 0.17; Standard Deviation--$\bar{X}$ = 0.66, S = 0.11; Skewness--$\bar{X}$ = 1.35, S = 0.71; Kurtosis--$\bar{X}$ = 8.07, S = 1.67

	Mean		Sorting		Skewness		Kurtosis		Method of Moment			
Sample No.	Inman M_ϕ	Folk Mz	Inman S_ϕ	Folk σ_i	Inman α_ϕ	Folk Sk_i	Inman K_G	Folk K_{GF}	Mean	Standard Deviation	Skewness	Kurtosis
01-00	2.51	2.45	0.44	0.42	0.36	0.36	0.50	1.20	2.50	0.56	1.81	11.11
01-03	2.23	2.22	0.31	0.32	0.11	0.17	0.73	1.06	2.27	0.52	0.72	8.21
01-04	2.49	2.44	0.52	0.52	0.27	0.23	0.64	0.90	2.51	0.68	0.94	5.55
01-05	2.20	2.20	0.35	0.38	-0.05	-0.04	0.94	1.32	2.29	0.55	0.84	7.94
01-07	2.26	2.26	0.48	0.51	-0.04	0.10	0.87	1.22	2.36	0.72	1.45	7.08
01-10	2.90	2.87	0.30	0.34	0.30	0.34	1.11	1.36	2.85	0.62	1.60	5.89
01-11	2.83	2.79	0.47	0.51	0.23	0.27	0.97	1.33	2.80	0.68	1.46	5.74
01-13	2.19	2.17	0.51	0.57	0.14	0.25	1.03	1.17	2.23	0.79	1.47	6.10
01-14	2.79	2.78	0.34	0.41	0.13	0.18	1.30	1.81	2.73	0.63	1.92	7.67
01-16	2.27	2.23	0.35	0.37	0.28	0.37	0.90	1.21	2.33	0.64	1.26	7.67
01-18	2.60	2.59	0.35	0.39	0.09	0.18	1.05	1.27	2.56	0.54	2.40	11.13
01-19	2.71	2.68	0.36	0.44	0.25	0.30	1.44	1.53	2.71	0.63	2.10	8.31
01-23	2.38	2.35	0.41	0.41	0.19	0.28	0.70	1.08	2.45	0.60	1.23	8.02
01-24	2.63	2.61	0.39	0.48	0.15	0.20	1.42	1.72	2.66	0.68	1.69	7.34
01-25	2.28	2.24	0.30	0.32	0.40	0.52	0.91	1.19	2.35	0.60	1.27	8.27
01-26	2.30	2.26	0.33	0.34	0.30	0.37	0.84	1.21	2.40	0.58	1.28	9.12
01-27	2.42	2.44	0.44	0.48	-0.10	0.10	0.93	1.11	2.52	0.71	1.55	7.32
01-28	2.42	2.42	0.50	0.46	0.00	0.09	0.44	0.75	2.40	0.67	1.13	6.49
01-29	2.56	2.58	0.43	0.41	-0.13	-0.10	0.51	0.84	2.58	0.54	1.20	7.76
01-30	2.66	2.67	0.38	0.40	-0.03	0.03	0.85	1.10	2.69	0.60	1.92	8.38
01-31	2.42	2.42	0.50	0.52	0.00	0.06	0.83	1.11	2.46	0.70	1.24	6.49
01-33	2.48	2.47	0.45	0.49	0.06	0.12	1.00	1.25	2.52	0.63	1.24	7.31
01-34	2.32	2.32	0.34	0.34	0.01	0.06	0.69	1.08	2.38	0.46	0.01	6.86
01-35	2.33	2.32	0.36	0.36	0.09	0.21	0.67	1.08	2.41	0.57	1.22	9.05
01-38	2.34	2.32	0.35	0.35	0.11	0.20	0.67	0.97	2.41	0.52	0.91	8.80
01-40	2.30	2.28	0.37	0.39	0.13	0.22	0.90	1.22	2.36	0.62	1.21	7.90
01-42	2.32	2.30	0.40	0.48	0.10	0.18	1.31	1.54	2.36	0.60	1.48	8.93
01-43	2.36	2.37	0.44	0.45	-0.03	0.05	0.70	1.03	2.41	0.62	1.08	7.16
01-45	2.41	2.39	0.35	0.39	0.21	0.24	1.01	1.24	2.48	0.55	1.36	9.63
01-49	2.49	2.47	0.35	0.36	0.11	0.18	0.77	1.10	2.56	0.47	2.02	12.95
01-75	2.16	2.16	0.33	0.38	0.04	0.17	1.11	1.26	2.20	0.67	1.39	7.29
01-76	2.81	2.75	0.33	0.39	0.48	0.58	1.34	1.51	2.78	0.60	2.27	7.95
01-77	2.61	2.57	0.34	0.44	0.32	0.46	1.66	2.06	2.67	0.59	2.53	10.44

TABLE 2.

MINERAL COMPOSITION OF SELECTED THIN SECTIONS

Results of point-count identification of 100 grains from each thin section. Rock type after Folk (1954)

Sample No.	Percent common quartz	Percent chert and opal	Percent total Q	Percent polycrystalline quartz	Percent mica	Percent total M	Percent K-feldspar	Percent plagioclase feldspar	Percent total F	Rock Type
01-00	59	2	61	11	---	11	28	---	28	iA
01-03	64	1	65	9	---	9	23	3	26	A
01-04	55	1	56	20	---	20	24	---	24	fs G
01-05	73	---	73	2	---	2	24	1	25	A
01-07	61	2	63	9	---	9	28	---	28	A
01-10	59	1	60	5	---	5	35	---	35	A
01-11	58	---	58	9	---	9	33	---	33	A
01-13	59	2	61	8	---	8	31	---	31	A
01-19	67	---	67	3	---	3	39	1	40	A
01-23	64	3	67	6	---	6	26	1	27	A
01-26	58	---	58	12	---	12	30	---	30	iA
01-30	66	---	66	6	---	6	28	---	28	A
01-35	60	---	60	4	---	4	36	---	36	A
01-40	56	---	56	8	---	8	36	---	36	A
01-49	64	1	65	4	---	4	31	---	31	A

TABLE 3

NUMBER PERCENT OF HEAVY MINERAL GRAINS, SELECTED SAMPLES

Sample No.	Percent tourmaline	Percent zircon	Percent leucoxene	Percent rutile	Percent biotite	Percent muscovite	Percent sphene
01-01	6	22	68	4	---	---	---
01-10	4	34	54	8	---	---	---
01-19	3	60	31	6	---	---	---
01-29	4	12	74	10	---	---	---
01-45	1	69	24	4	2	---	---
01-49	4	38	50	8	---	---	---

LOCALITY 2

by

Charles F. Dodge

Locality 2 is situated along Farm Road 157, beginning on the south side of the bridge across the West Fork of the Trinity River and extending

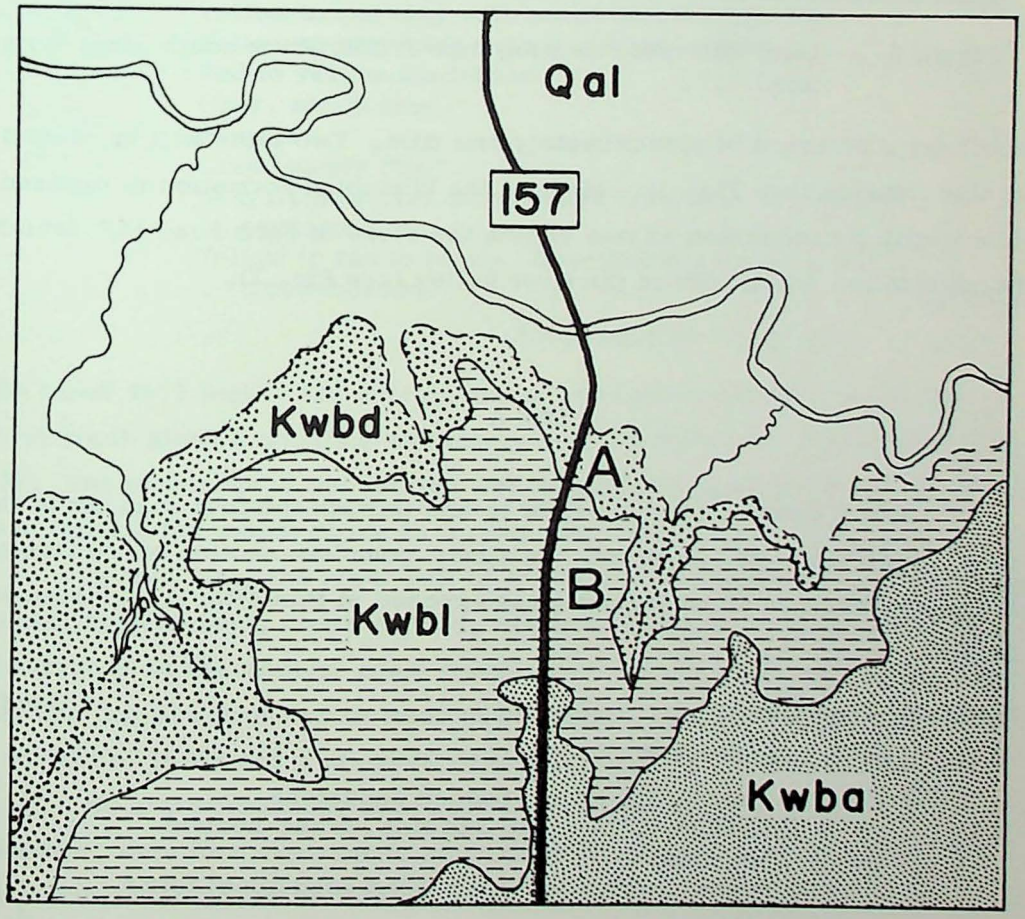


Figure 1.--Site map for Locality 2. Scale: one inch = 2,000 feet. Kwba = Arlington Member, Kwbl = Lewisville Member, Kwbd = Dexter Member, Woodbine Formation.

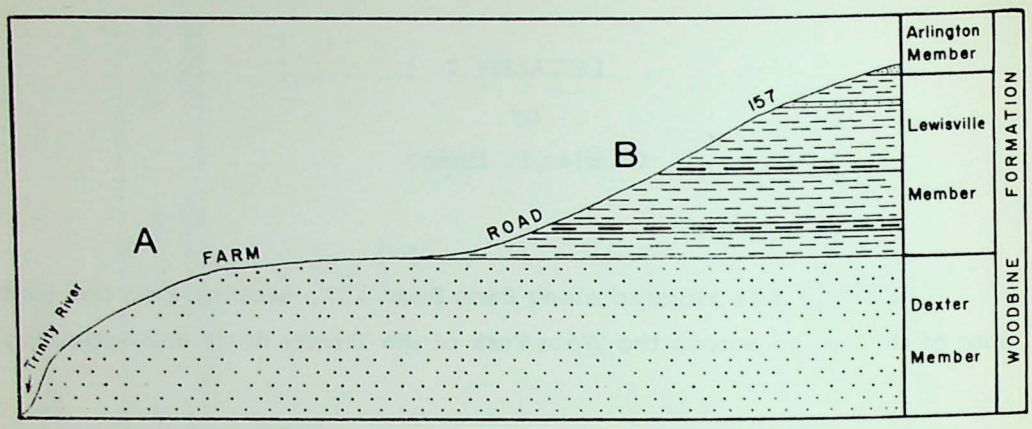


Figure 2. -- Geologic cross section from Trinity River south along Farm Road 157.

south for a distance of approximately one mile. Two sites will be visited at this locality (see Fig. 1). Most of the Woodbine Formation is exposed in ascending succession as one climbs the slope of Farm Road 157, which is cut into the south side of the river valley (see Fig. 2).

Site A

Site A extends from the river to and through the first road cut to the south, a distance of 0.6 miles. An almost complete section of the Dexter Member of the Woodbine Formation is exposed at this site; it is described below:

Woodbine Formation	Feet
Dexter Member	
White to tan, cross-bedded sandstone	15.1
Interbedded ironstone and fine, cross-bedded sandstone	0.3
White to yellow, cross-bedded sandstone; forms ledges	3.0
Gray to tan clay	0.3
Yellow to red, laminated sandstone	0.5
White, cross-bedded sandstone, weathering to shades of brown	8.3

	Feet
Interbedded gray, sandy clay and ironstone	0.5
White to tan sandstone with nodules of ironstone	3.0
Gray, laminated sandstone	1.3
Disconformity	
Gray clay	0.3
Yellow to red sandstone	0.3
Interbedded gray clay and yellow to red sandstone	1.0
Yellow to red, banded sandstone	0.7
Brown sandstone	0.1
Gray to red clay	0.3
Gray to tan shale	1.3
Yellow to red clay with small ironstone bands	0.5
Yellow to gray clay with ironstone bands	0.9
Red to yellow sandstone	0.3
Gray, sandy clay	1.1
Red clay	0.5
Gray, sandy clay	1.1
Gray, sandy clay interbedded with gray to yellow sandstone	6.1
Yellow to tan to brown, fine-grained sandstone; cross-bedded	45.3
Total exposed thickness	92.1

The lower 45.3 feet of the section above were measured from the Trinity River south along a tributary streamway located 200 feet west of Farm Road 157. The remainder of the section was measured along the west side of the road through the extent of the first road cut.

At this site, the lower half of the unit is composed of reddish-brown to tan, fine-grained, cross-bedded, blanket sandstone. All cross-bedding observed is of the medium-scale trough, or cut-and-fill, type. The cross-bedding dip-direction vector mean of 25 random measurements is 184° with a variant of 10306 and a standard deviation of 101°.

No grain-frequency data have been obtained on this sand body. However, data from comparable units located several miles to the north show the sandstone to be fine grained, with an average mean grain size of 2.75 ϕ. These sand bodies are well sorted, with an average value of 0.45, and are positively skewed.

Overlying this cross-bedded lower portion of the Dexter are approximately 15 feet of claystone and silty claystone with a few thin, interbedded stringers of fine sandstone.

Overlying the silty clay are approximately 35 feet of well-bedded tan sandstone. The individual beds are up to 8 feet thick and are separated by thin beds of gray clay. The basal surface of this unit is irregular and probably represents a minor erosional surface. In several places along the exposure, the surface is overlain by clay breccia with clay chips up to one inch in diameter in a fine sand matrix. The most characteristic feature of these sandstone beds is their ripple-drift, or climbing-ripple, cross-bedding. The current flow direction indicated by these ripples is generally to the south.

Grain-frequency data indicate that these sandstones are fine grained and moderately well sorted. Average mean-grain size is 3.40 ϕ, and the average sorting value is 0.60. Skewness values range from -0.20 to +0.34.

Environmentally, the lowermost sand unit, with its very good sorting, blanket nature, trough-type cross-bedding, probably represents a regressive marine sand body deposited above wave base. The upper, well-bedded unit, with its moderate sorting, ripple-drift cross-bedding and basal erosional surface, probably represents a fluvial or distributary channel fill. The environment of deposition for the silty clays is not indicated at this time.

Site B

Site B extends from 0.6 miles south of the bridge over the Trinity River south to the crest of the hill.

A complete section of the Lewisville Member of the Woodbine Formation can be seen in the road cuts on both sides of Farm Road 157. The Lewisville contact with the underlying Dexter Member is gradational, and the first gray to brown, fissile shale is taken as the base of the Lewisville Member.

A detailed section of the Lewisville, measured in the stream valley located just east of Farm Road 157, is given below:

Woodbine Formation	Feet
Lewisville Member	
Yellow to gray, sandy clay	10.3
Yellow to brown, sandy clay	0.1
Dark red, fossiliferous ironstone	0.5
Brown clay	0.8
Yellow to tan, sandy clay	1.1
Red to brown to tan sandstone interbedded with ironstone	0.9
Yellow to brown, interbedded sands and clays	1.3
Ironstone concretions	0.2
Gray to yellow, sandy clay	5.5
Dark red ironstone	0.1
Gray, sandy clay	0.3
Yellow to red, fossiliferous ironstone	0.3
Yellow to gray clay interbedded with white sand	2.0
Thinly bedded yellow to red ironstone	0.4
Tan to yellow sandstone forming ledges; some gray clay irregularly interbedded	6.4
Yellow to gray, sandy clay with some lignite near top	10.7
Red ironstone	0.6
Yellow to gray, sandy clay	0.6
Yellow to tan sandstone; forms ledges	1.4
Gray clay interbedded with white sand; some ironstone concretions	3.9
Gray sandstone, well indurated and jointed; forms ledges	0.7
Mottled gray and black siltstone	1.5
Yellow to brown ironstone	0.5
White to yellow, sandy clay	0.3
Red to yellow sandstone, well indurated and jointed; forms ledges	1.9
Interbedded gray to yellow siltstone, gray to brown clays and white quartz sandstone; bedding very irregular	22.1
Black laminated, carbonaceous shale containing small sand lenses, layers of lignite, and gypsum crystals	13.5
Yellow to brown, sandy clay with abundant gypsum crystals	1.3
Shell bed, Ostrea sp.	0.3

	Feet
Gray to yellow clay containing some lignite; gypsum crystals concentrated in six-inch bed near middle	10.3
Yellow to red, rippled sandstone; ironstone concretions near top	1.1
Gray to brown, fissile shale	5.3
Total thickness	106.2

One of the most striking features of the Lewisville Member in Tarrant County is its lenticular sand body development, which, unfortunately, is not exhibited in this outcrop. At other localities in the county, over 20 lenticular sand bodies have been defined. Of these, 12 have been described in detail. Dodge (1965) described an offshore bar from the lower portion; Dodge, Robertson, and Howard (1966) described a wave-cut bench and wave-built terrace from the upper portion; and Dodge (1966) gave detailed descriptions of ten channel sand bodies from the Lewisville.

Both the transitional-marine sand bodies mentioned above are well sorted and very fine to fine grained. The wave-built terrace has an average sorting value of less than 0.30 ϕ, an average mean grain size of 3.25 ϕ, and is negatively skewed. The offshore bar has an average sorting value of slightly over 0.50 ϕ, an average mean grain size of 2.50 ϕ, and is positively skewed.

The ten channel sand bodies mentioned above are well to moderately well sorted, fine grained, and positively skewed. Sorting values range from 0.35 ϕ to 0.92 ϕ and average slightly over 0.60 ϕ. Mean grain size averages 2.50 ϕ. Directional parameters, both cross-bedding dip and grain orientation, indicate a general southerly flow direction for the depositing streams. Most of these sand bodies probably represent deltaic distributary channel fills.

The channel sands range from arkose to impure arkose, using Folk's (1954) classification. The dominant nonmagnetic heavy minerals are leucoxene and rounded zircon, with traces of rutile and sphene. The provenance area for these channel sand bodies would appear to be south-central Oklahoma, with considerable contribution coming from the Wichita Mountain area.

In the Lewisville section seen along this road cut, there are two well-developed lignitic shale units. The occurrence and position of lignitic shale units in the Lewisville are quite variable and probably represent deposition in swamp or marsh environments.

Several thin fossil beds also occur throughout the Lewisville. Gastropods, pelecypods, and brachiopods are commonly present; and in some of the thin sand units, both fish teeth and vertabrae have been found. These seem to indicate minor phases of delta top submergence and the development of marginal open bay or shallow marine shelf environments.

LOCALITY 3

by

C. L. McNulty, Jr.

and

Bob H. Slaughter

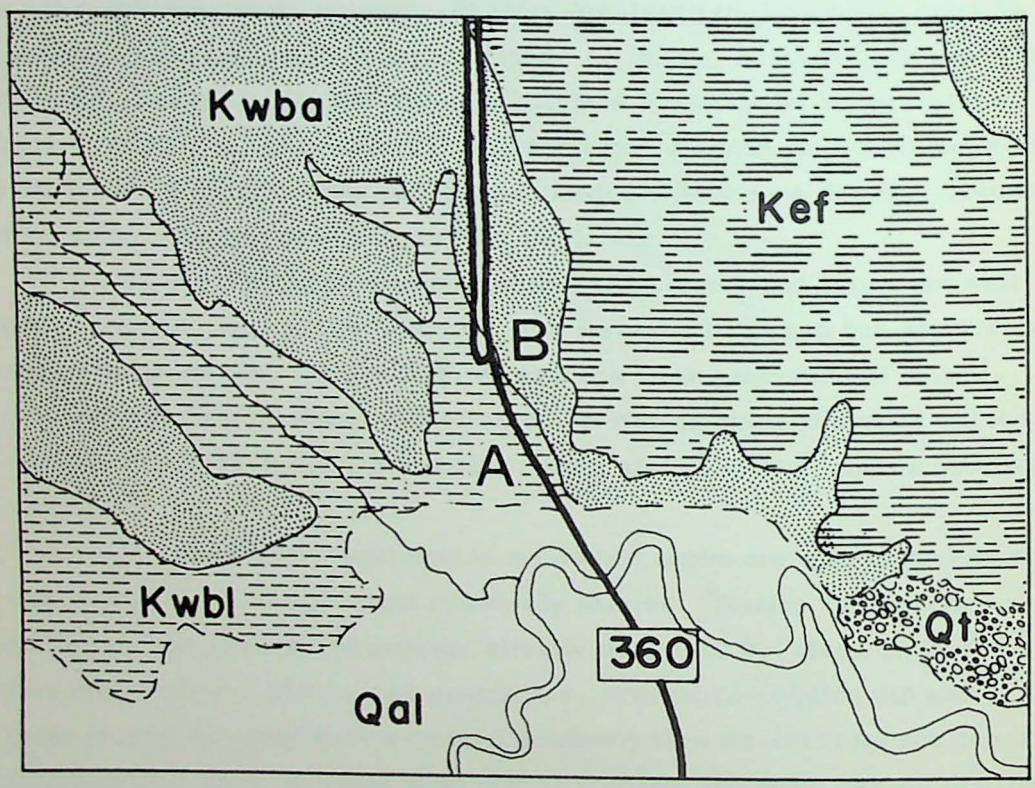


Figure 1.--Site map for Locality 3. Scale: one inch = 2,000 feet. Kef = Eagle Ford Formation; Kwba = Arlington Member, Kwbl = Lewisville Member, Woodbine Formation.

Site A

Site A is a road cut on the east side of State Highway 360 immediately north of the Chicago Rock Island and Pacific Railroad overpass. In it are

exposed 27 feet of Lewisville Member and 12 feet of Arlington Member (Fig. 2).

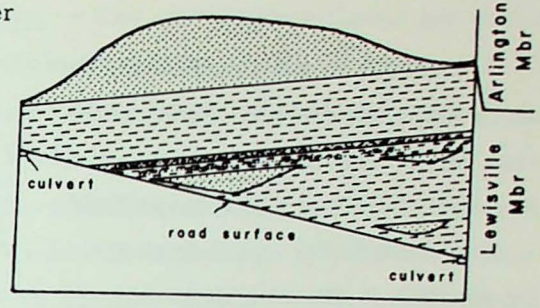


Figure 2.-- Site A. one inch = 300 feet horizontally and 20 feet vertically.

The Lewisville is mainly gray jarositic to black lignitic, gypsiferous shale, but it contains many lenses and thin beds of light brown, quartz sandstone. This site provides a superior view of the nature and abundance of sandstone bodies in the Lewisville Member.

Of particular interest are two three- to six-inch beds of coquinoid lignitic, gray quartz sandstone, which may be identified by their reddish brown color of weathering. The molluscan fauna is dominated by corbulids, arcids, and ostreids. Macrurous decapods, lingulid brachiopods and fragmentary vertebrate remains are also present. Chelonial debris appears to be the most abundant of the vertebrate material, but galeoid, batoid and holostean fishes, crocodilians, and even archosaurian fragments occur.

The Arlington Member is a light brownish gray, coarse-grained, quartz sandstone. At first glance the unit appears to be thick bedded and massive, but close examination of clean exposure, as at Site B, reveals that it is considerably cross-bedded and lenticular in structure. Many lenses are coquinoid, and the pelecypods are mainly taxodont and desmodont, ostreid, or a mixture of the two (Stephenson, 1952). Patches of ostreid coquina and scattered lenses of acanthocerid ammonites occur at the top of the Member in this exposure. Also present at or near the top are irregular patches and lenses of sandy quartz and phosphorite conglomerate with abundant vertebrate debris, such as will be seen better at Site B.

Site B

Site B is an exposure in bar ditch and road cut along the north side of the service road to Frontier Airlines Operations Building in the southwest quarter of Southwest International Airport. It is 200 yards north of Site A.

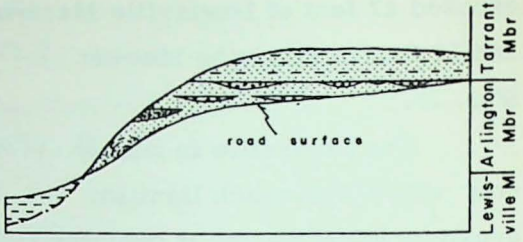


Figure 3.-- Site B. one inch = 300 feet horizontally and 20 feet vertically.

The exposure shows six feet of gray, jarositic Lewisville shale and 12 feet of brown, thick-bedded Arlington sandstone. The lower six feet of sandstone contain ill-defined ironstone concretions of three to six feet in diameter. The Arlington is overlain by four feet of yellowish brown, poorly indurated, argillaceous quartz sand, apparently of the Tarrant Member (Fig. 3).

The main point of interest at this site is the distinctive but erratic development of sandstone conglomerate in the upper four feet of the Arlington Member. It is peculiar in an abundance of phosphoritic granule-pebbles and vertebrate fragments, which are mostly fish teeth. The conglomerate is most continuous at the top of the Arlington, but it is common also at a horizon about two feet below the top and may occur much lower (Stephenson, 1952, p. 13). Although the conglomerate has excited stratigraphic speculation for forty years, nothing has been published about the vertebrate fauna.

Stratigraphic Inference from the Conglomerates.--Stephenson (1929) was one of the first to note the association of glauconitic-phosphoritic rudite, fish debris, and uneven, if not burrowed or bored, contacts. He considered them evidence of disconformity. Among the examples cited in this argument was the conglomerate of Site B, which was presented as powerful evidence of disconformity at the Woodbine-Eagle Ford contact from Tarrant County south to the Woodbine pinchout. The significance accorded the conglomerate and associated contact has changed with time (Stephenson, 1946, 1952), and the unit is presently considered indicative of local unconformity within the upper Woodbine. It may prove a fragmentary record of strand passage prior to Eagle Fordian inundation.

Vertebrates of the Conglomerate.-- The vertebrate remains are quite fragmentary and consequently susceptible to varying levels of taxonomic differentiation. Only a faunal list is practical for this Guidebook, but representative taxa are illustrated in Plate I.

Pisces: Hybodus sp., Odontaspis sp., Odontaspis gracilis (Williston) [=Scyllium gracilis Williston], Lamna planidens (Williston) [=Scyllium planidens Williston], Lamna sulcata Geinitz, Squalicorax sp., Onchopristis dunklei McNulty and Slaughter, Ptychodus sp., Hypolophus cf. H. sylvestris White, Semionotid teeth (Lepidotus cf. L. mantelli Agassiz), Pycnodontid teeth (?Microdon sp., ?Anomoeodus sp.), Enchodus sp.

Reptilia: Chelonia (unidentified), Crocodilia, ?Mesosuchian.

Mammalia: Theria, Multituberculata (eucosmodontid).

Galeoid and semionotid teeth are the most abundant elements of the fauna; but crocodilian, pycnodont, onchopristid rostral, and hypolophid teeth are also common. Other elements are rare, including turtle, which appears dominant in the coquinoid beds of Site A. Only one eucosmodontid incisor and one therian premolar have been found.

Many specimens are abraded, some severely. But we are reluctant to infer long distance of transport, primarily because the assemblage appears lagoonal-neritic and the other aspects of stratigraphy suggest the same environment.

EXPLANATION OF PLATE I

Figure 1a-c: *Hybodus* sp., teeth, X 3.5; a = internal aspect, b = external aspect, c = lateral aspect.

2: *Hybodus* sp., medial fin spine, X 3.5; left-lateral aspect.

3a-c: *Odontaspis* sp., teeth, X 3.5; a = internal aspect, b = external aspect, c = lateral aspect.

4a-b: *Odontaspis gracilis* [=*Scyllium gracilis* Williston], teeth, X 3.5; a = internal aspect, b = lateral aspect.

5a-c: *Lamna sulcata* Geinitz, teeth, X 1.25; a = internal aspect, b = external aspect, c = lateral aspect.

6a-c: *Lamna planidens* [=*Scyllium planidens* Williston], teeth, X 4.0; a - internal aspect, b = external aspect, c = lateral aspect.

7a-c: *Onchopristis dunklei* McNulty and Slaughter, basal portion of barbed, rostral teeth, X 4.0; a = dorsal aspect, anterior toward left; b = ventral aspect, anterior toward right.

8a-c: *Squalicorax* sp., teeth, X 3.5; a = internal aspect, b = lateral aspect, c = external aspect.

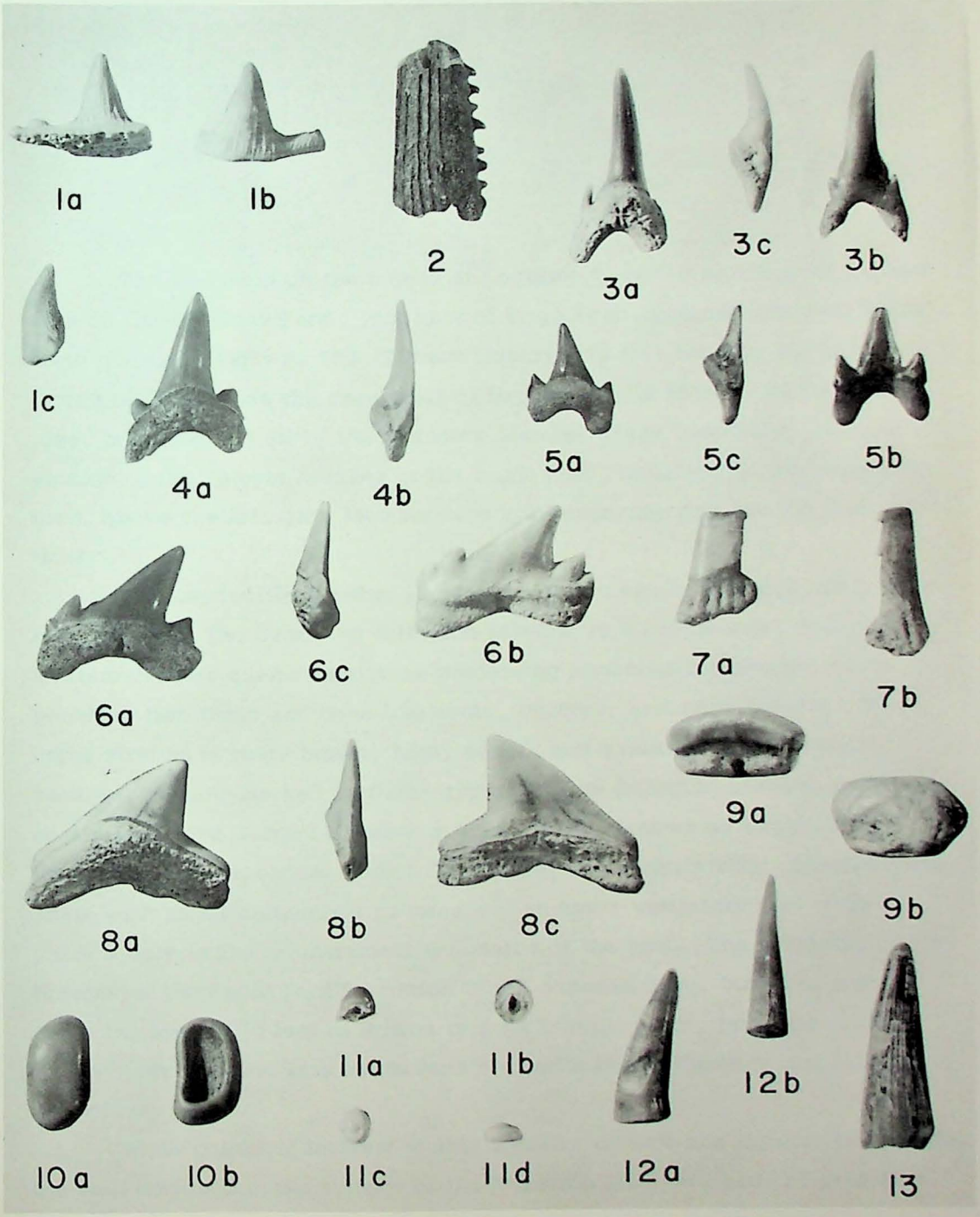
9a-c: *Hypolophus* cf. *H. sylvestris* White, durophagous teeth, X 4.0; a = external aspect; b = occlusal aspect, anterior toward top.

10a-b: Pycnodontid triturial teeth, X 2.0; a = occlusal aspect, b = basal aspect.

11a-d: Semionotid triturial teeth (*Lepidotus mantelli* Agassiz), X 1.25; a = lateral aspect of peripheral tooth, b = basal aspect of medial tooth, c = occlusal aspect of medial tooth, d = lateral aspect of medial tooth.

12a-b: *Enchodus* sp., primary teeth, X 2.25; a = lateral aspect, anterior toward left; b = posterior aspect.

13: Crocodilian tooth, X 1.5; lateral aspect.


1a
1b
2
3a
3c
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8a
8b
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9a
9b
10a
10b
11a
11b
11c
11d
12a
12b
13

PLATE I

LOCALITY 4

by

J. Dan Powell

Site A

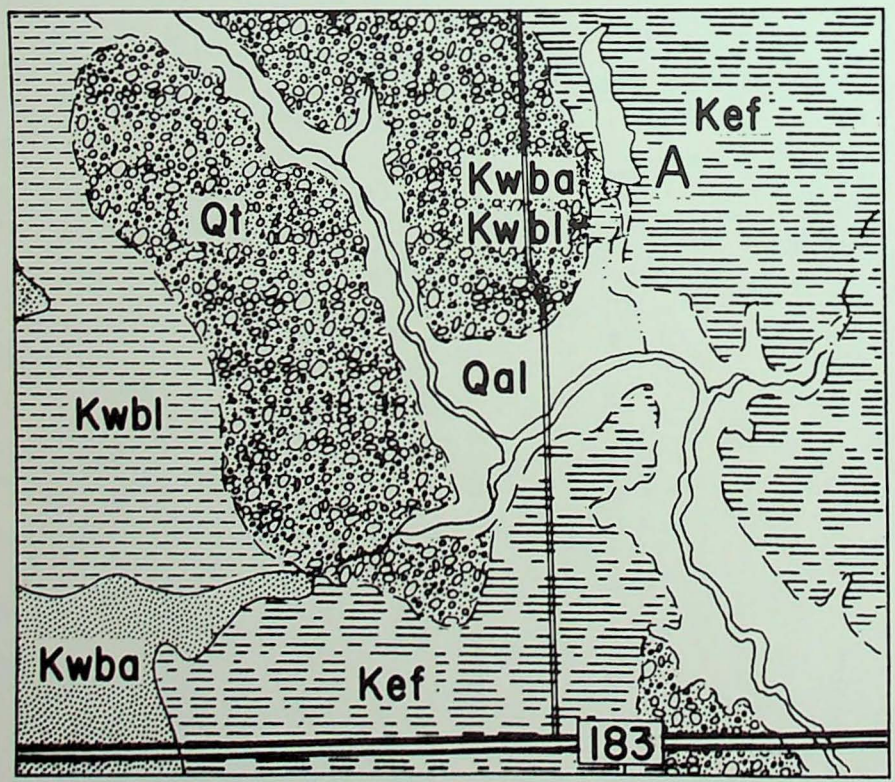
The last stop on the trip is at Locality 4, at the spillway of a small lake on the Moroney Farm, just east of Trigg Road, one and one-half miles north of Texas Highway 183, Tarrant County. At this locality the east-facing bluff exposes the upper part of the Lewisville Member of the Woodbine Formation and all of the Arlington Member of the Woodbine. A complete section of the Tarrant Member of the Eagle Ford Formation is also exposed here, above the Arlington Member (see accompanying map and graphic section).

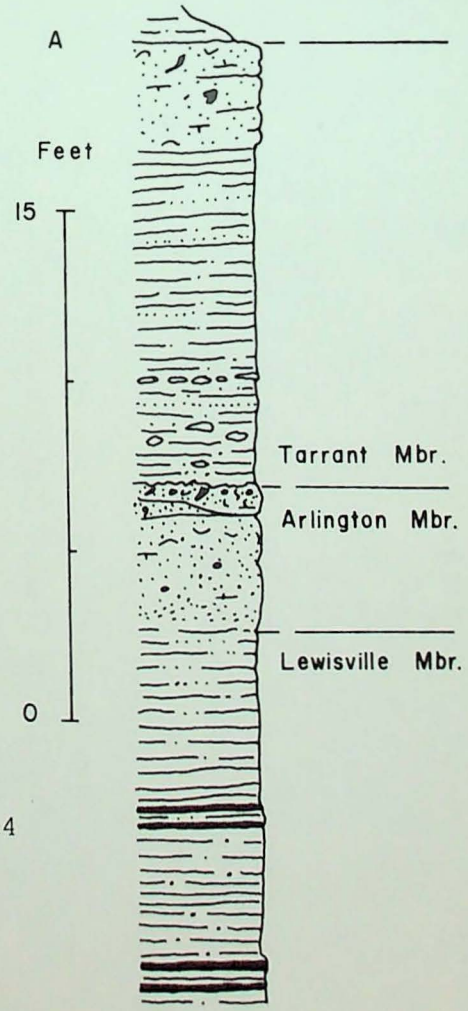
The Lewisville Member is mainly lignitic shale with thin sandy beds near the top. The overlying Arlington Member is a calcareous, fine- to medium-grained quartz sandstone containing phosphatic granules, chert pebbles, fish teeth and bone fragments, oysters, and other fossils. The upper stratum is rusty brown, hard, pebbly and oyster-bearing, with a scoured, current-marked surface--typical of the Arlington Member in adjacent areas. The Tarrant Member at this locality (known as Locality 60 in the Tarrant article earlier in this Guidebook) is primarily silty claystone and shale with small calcareous nodules and an upper sandstone bed which is present only in the northernmost exposures of the unit. The overlying Britton Member of the Eagle Ford Formation is not exposed here, but in adjacent areas the lower 100 feet of Britton is a dark-gray, silty, jarositic clay, which grades upward into calcareous clay with bentonite beds and finally into clayey chalk.

Main points of interest at this locality include the lignitic Lewisville, the well-exposed upper surface of the Arlington Member, and the complete

Tarrant section with the three-foot sandstone unit at the top.

Fauna lists and measured sections are included in the earlier article on the Tarrant Member (this Guidebook).





EXPLANATION: The letter "A" is located just southeast of the Locality 4 exposure. Kwbl = Lewisville Member, Kwba = Arlington Member, Woodbine Formation; Kef = Eagle Ford Formation (including Tarrant Member at base). Scale: one inch = 2,000 feet.

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Figure 1.-- Map of the eastern half of Tarrant County, Texas, showing the various localities cited in the text.

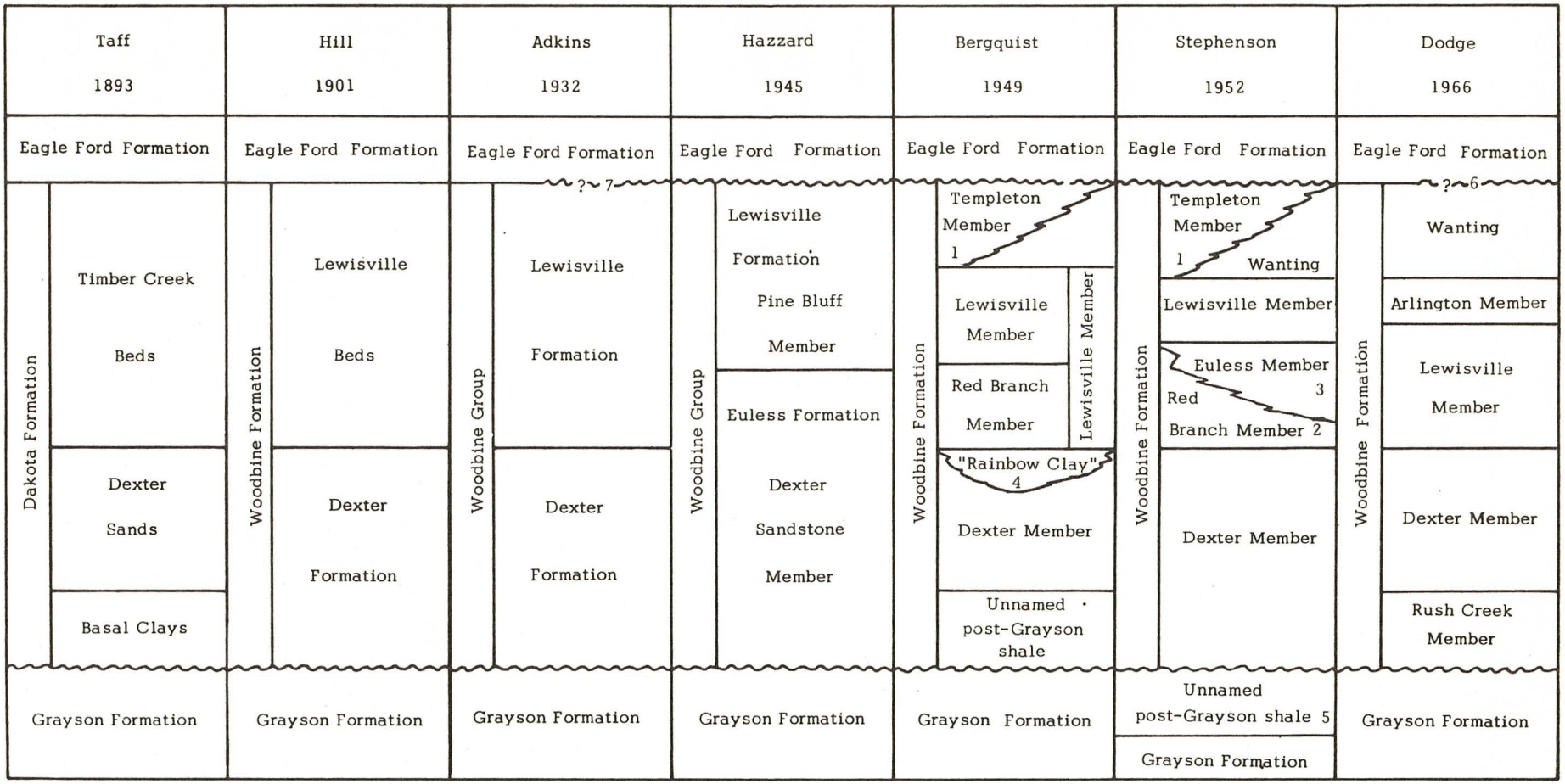


Figure 2.--Correlation chart for the Woodbine Formation of North Texas. (1) Not present south of central Denton County. (2) Not present in Tarrant County. (3) Lower Lewisville. (4) Not everywhere present. (5) Placed in Comanchean by Stephenson. (6) and (7) Relationship questionable.

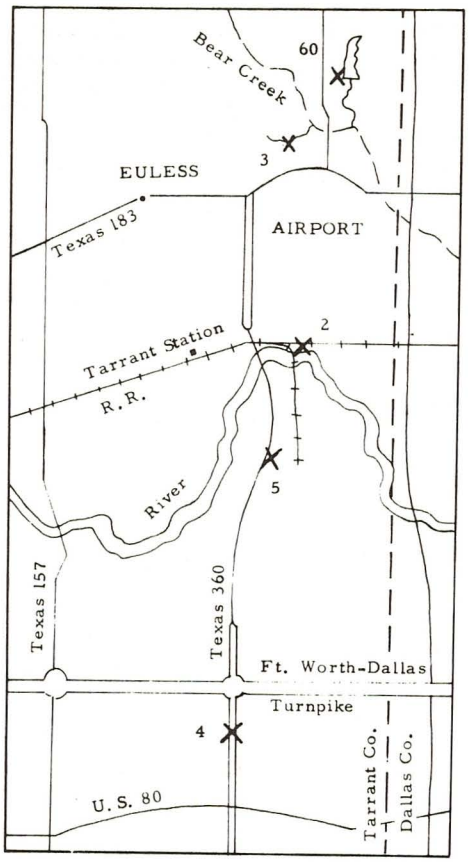


FIGURE 1 -- MAP SHOWING LOCALITIES

Tarrant County, Texas

N

EXPLANATION

X 5 Localities referred to in text

Approximate Scale

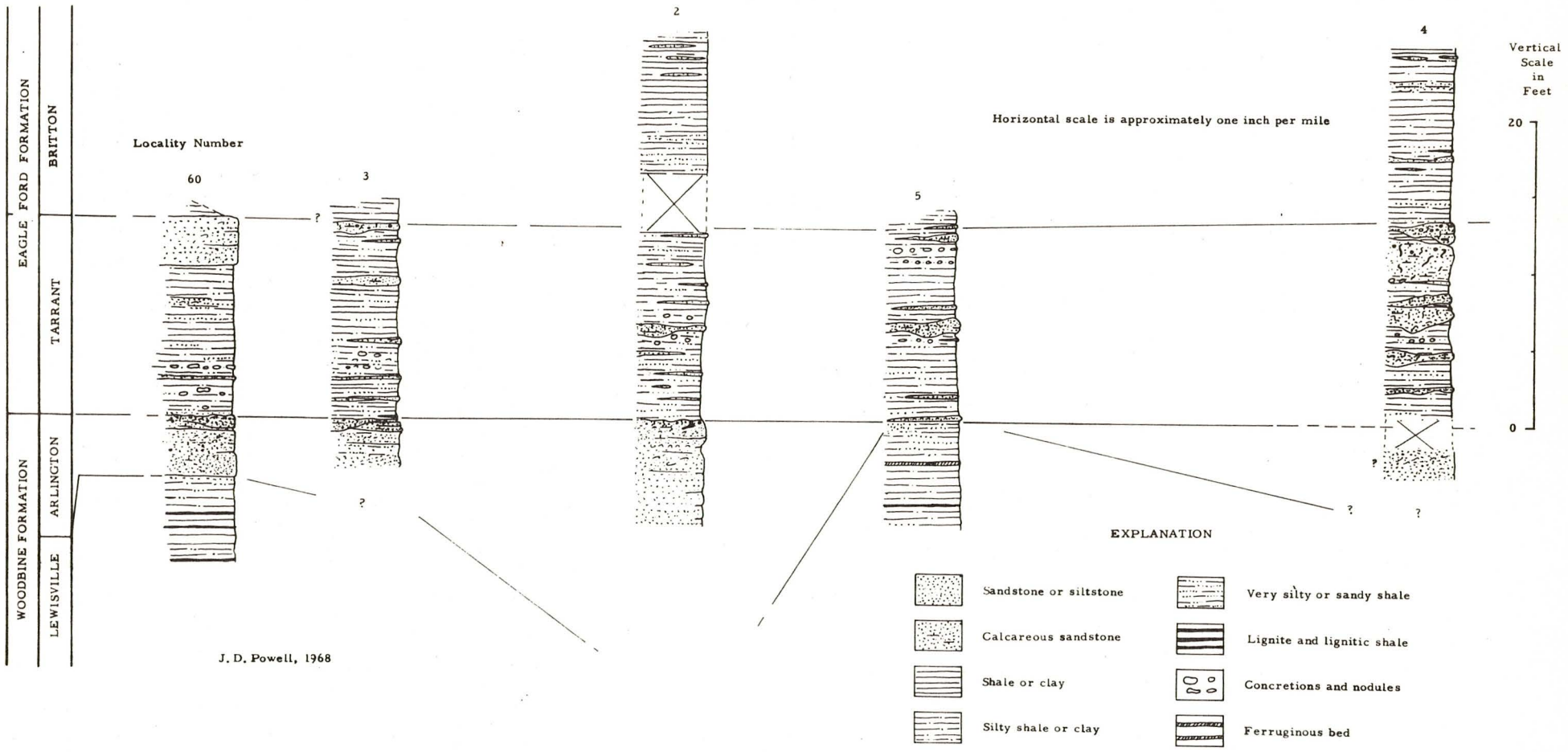
One Mile

J. D. Powell, 1968

east of Tarrant Station (Fig. 1); (actually one to one and one-half miles east of Tarrant Station). Here (loc. 2 on figs. 1 and 2), and in adjacent areas north and south, the Woodbine-Eagle Ford transition (Tarrant) is marked by complex lithologic variation, both vertically and along strike, spanning a stratal thickness of from 4 to 20 feet. This fact, along with the inconsistent position of the transition zone with respect to marker beds in the Eagle Ford clay, indicates an intertonguing of adjacent units of the two formations. However, relatively insignificant breaks in deposition undoubtedly occur within the zone.

For purposes of this Guidebook, the writer has mapped (with contributions of data from C. F. Dodge) the zone of transition (Fig. 1). Figure 2 represents measured sections along the outcrop showing the position and

FIGURE 2 -- CORRELATION OF MEASURED SURFACE SECTIONS



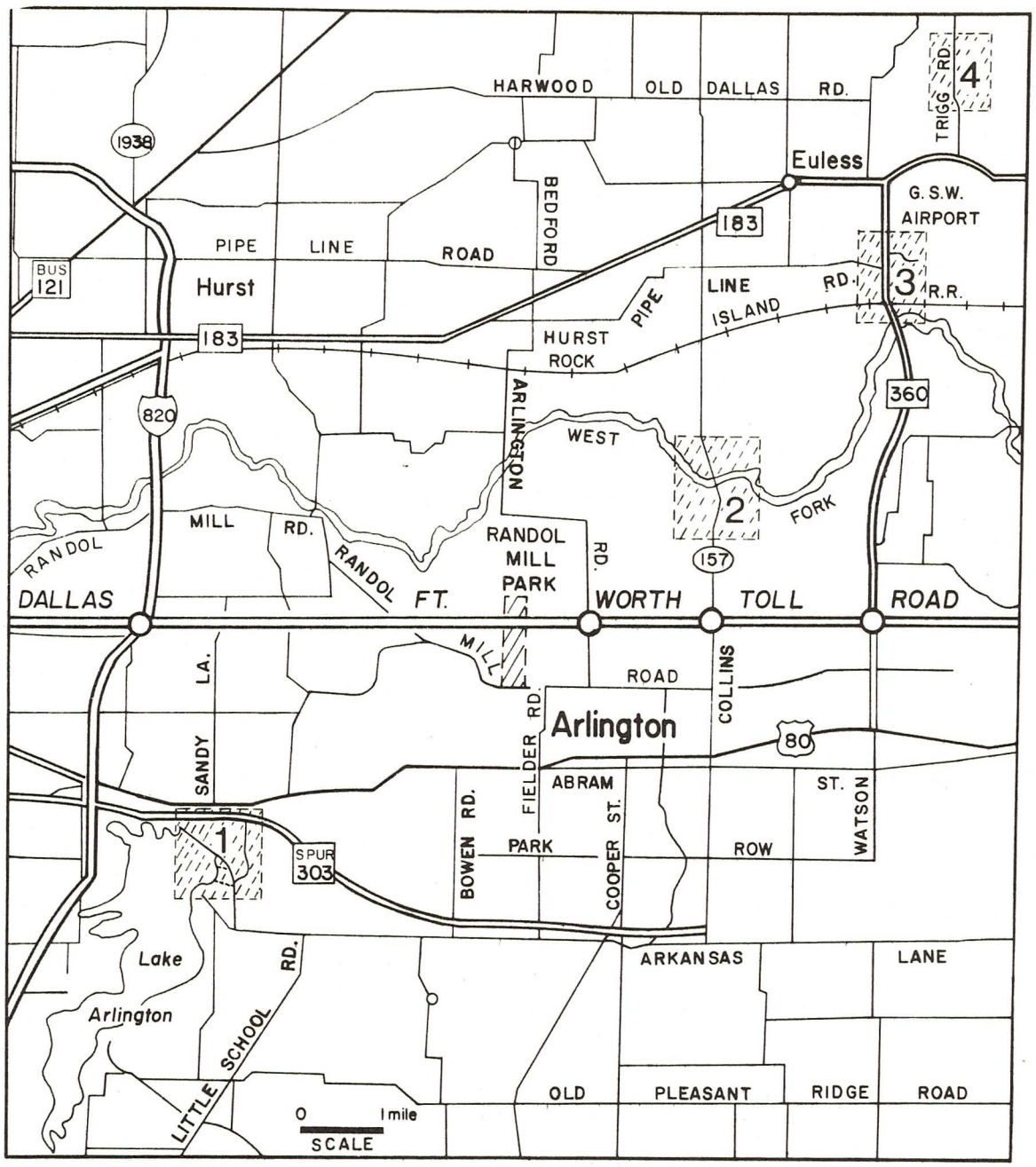


Figure 1.-- Map showing Field Trip localities.

LOCALITY 1

by

Charles F. Dodge

Locality 1 is in and around the emergency spillway excavation on the northeast shore of Lake Arlington, located 5 miles east of Arlington,

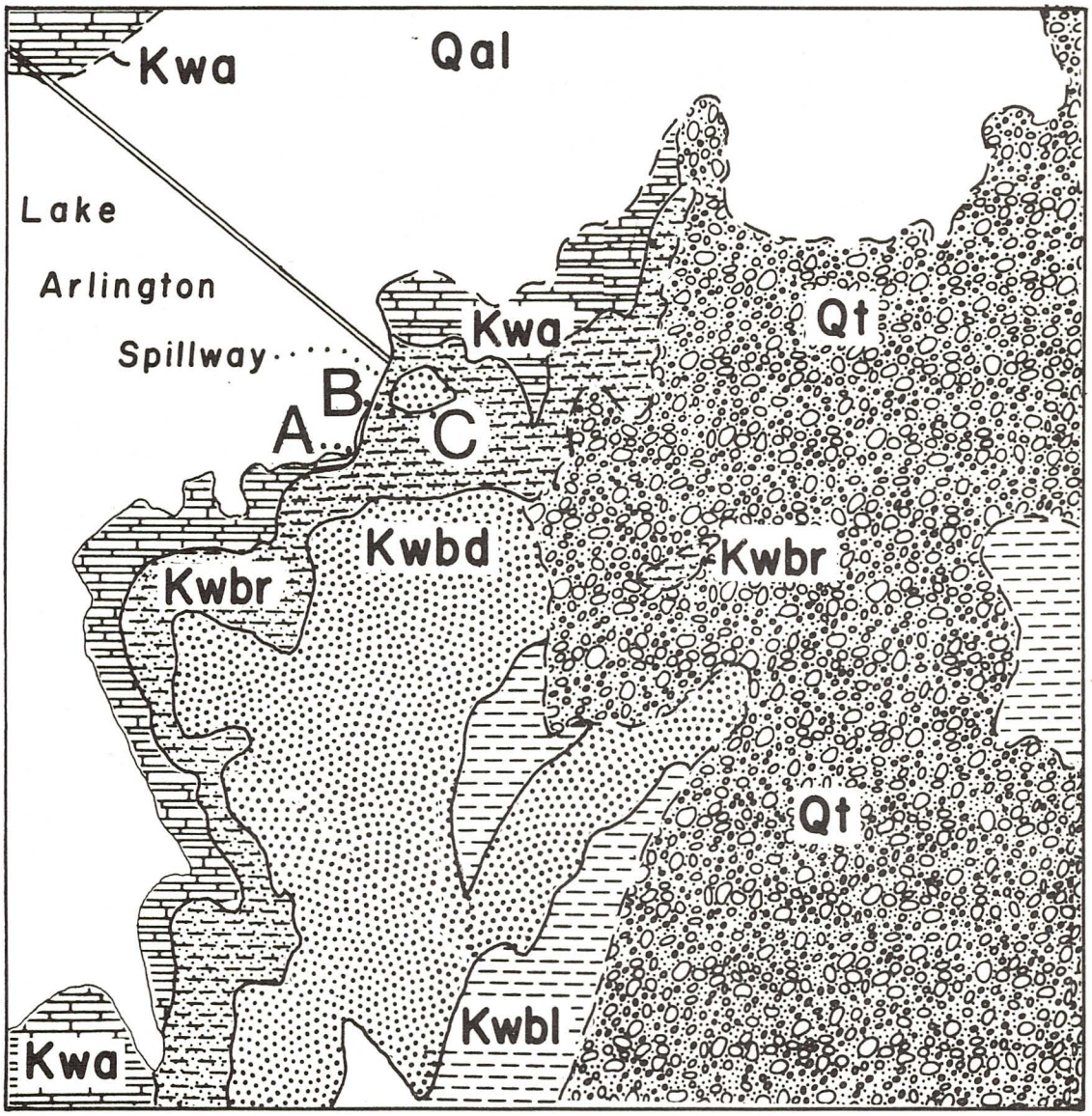


Figure 1.--Site map for Locality 1. Scale: one inch = 2,000 feet. Kwbl = Lewisville Member, Kwbd = Dexter Member, Kwbr = Rush Creek Member, Woodbine Formation; Kwa = Washita Group.

Texas. The geology of the area is shown in figure 1, and a generalized cross section of the north wall of the cut is shown in figure 2. Locations of Sites B and C are designated on both the map and the cross section. Site

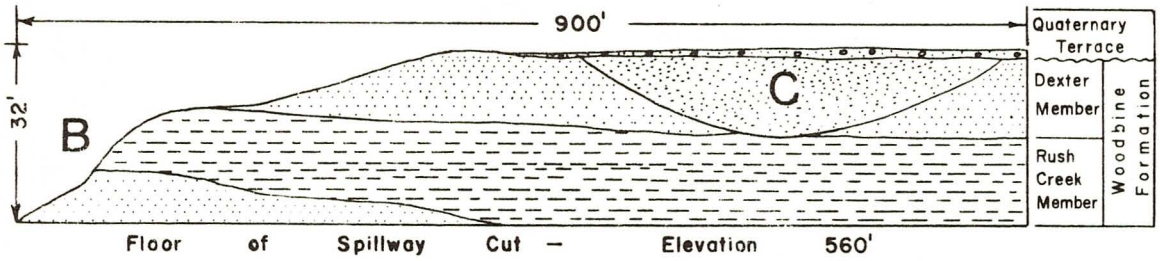


Figure 2.-- Geologic cross section of north wall of spillway cut.

A is located at the base of the south wall of the spillway cut, 400 feet east of the lake shore.

Site A

Contact Between the Gulf Series and the Comanche Series

The contact between the Rush Creek Member of the Woodbine Formation and the Grayson Formation is marked here by a basal conglomerate. The conglomerate is up to 1.5 feet thick and grades upward into sandstone. It directly overlies gray calcareous shale of the Grayson Formation. The clastic particles of the conglomerate are very heavily cemented with a ferruginous cement, giving the rock a reddish-brown color. The clastic particles themselves vary from ferruginous clay chips ranging up to two inches in length to hematitic shell fragments and vertebrate remains such as fish centra and teeth, all in a fine-grained sand matrix.

Cement and replacement hematite make up approximately 40 percent of the conglomerate in areas where it is exposed or is in contact with a Quaternary terrace gravel deposit. Where this unit is not exposed, the cementation and replacement are much reduced, and chips of gray clay are imbedded in a fine sand matrix which has a mean size of about 3.25 ϕ units.

Imbrication of clay chips in the conglomerate indicates a N 10° W current direction. Figure 3 is a photograph of a cut surface of the conglomerate, showing both the clastic particle size and the pebble imbrication.

Figure 3.--A cut surface of the conglomerate from Site A.

At the type locality for the Rush Creek Member, the basal conglomerate is about one foot thick and is made up of cobbles and boulders of Grayson marl in a very fine-grained sand matrix. The upper part of the sand contains numerous ironstone concretions.

Site B

Rush Creek Member of the Woodbine Formation

A complete section of the Rush Creek Member of the Woodbine Formation is exposed in the west end of the walls of the spillway cut at Lake Arlington. The best section for viewing is located along the north wall of the cut. At this locality the Rush Creek is made up of a basal tan sandstone measuring up to 14 feet thick and a brown to black, slightly sandy shale unit measuring up to 25 feet thick.

The sand is very fine grained, with the 22 samples analyzed having a mean grain size of slightly over 3.0 ϕ units. Sorting values for these

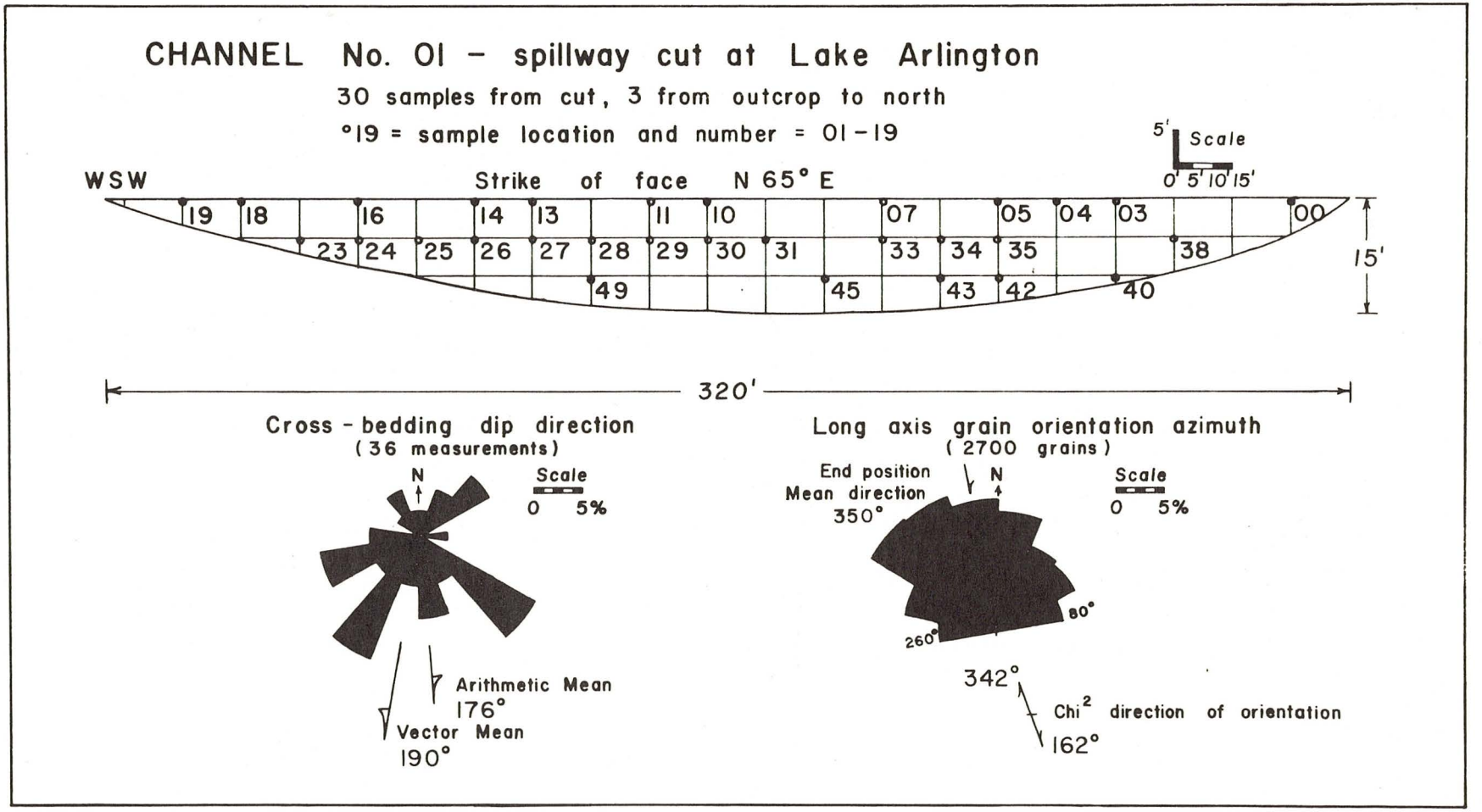


Figure 4.--Cross section scale diagram showing sample locations, cross-bedding dip direction, and long-axis grain-orientation azimuth.

TABLE 1

STATISTICAL PARAMETERS

Channel 01: Total Samples--33

Mean and Standard Deviation for Method of Moment Parameters: Mean--$\bar{X}$ = 2.49, S = 0.17; Standard Deviation--$\bar{X}$ = 0.66, S = 0.11; Skewness--$\bar{X}$ = 1.35, S = 0.71; Kurtosis--$\bar{X}$ = 8.07, S = 1.67

	Mean		Sorting		Skewness		Kurtosis		Method of Moment			
Sample No.	Inman M_ϕ	Folk Mz	Inman S_ϕ	Folk σ_I	Inman α_ϕ	Folk Sk_I	Inman K_G	Folk K_{GF}	Mean	Standard Deviation	Skewness	Kurtosis
01-00	2.51	2.45	0.44	0.42	0.36	0.36	0.50	1.20	2.50	0.56	1.81	11.11
01-03	2.23	2.22	0.31	0.32	0.11	0.17	0.73	1.06	2.27	0.52	0.72	8.21
01-04	2.49	2.44	0.52	0.52	0.27	0.23	0.64	0.90	2.51	0.68	0.94	5.55
01-05	2.20	2.20	0.35	0.38	-0.05	-0.04	0.94	1.32	2.29	0.55	0.84	7.94
01-07	2.26	2.26	0.48	0.51	-0.04	0.10	0.87	1.22	2.36	0.72	1.45	7.08
01-10	2.90	2.87	0.30	0.34	0.30	0.34	1.11	1.36	2.85	0.62	1.60	5.89
01-11	2.83	2.79	0.47	0.51	0.23	0.27	0.97	1.33	2.80	0.68	1.46	5.74
01-13	2.19	2.17	0.51	0.57	0.14	0.25	1.03	1.17	2.23	0.79	1.47	6.10
01-14	2.79	2.78	0.34	0.41	0.13	0.18	1.30	1.81	2.73	0.63	1.92	7.67
01-16	2.27	2.23	0.35	0.37	0.28	0.37	0.90	1.21	2.33	0.64	1.26	7.67
01-18	2.60	2.59	0.35	0.39	0.09	0.18	1.05	1.27	2.56	0.54	2.40	11.13
01-19	2.71	2.68	0.36	0.44	0.25	0.30	1.44	1.53	2.71	0.63	2.10	8.31
01-23	2.38	2.35	0.41	0.41	0.19	0.28	0.70	1.08	2.45	0.60	1.23	8.02
01-24	2.63	2.61	0.39	0.48	0.15	0.20	1.42	1.72	2.66	0.68	1.69	7.34
01-25	2.28	2.24	0.30	0.32	0.40	0.52	0.91	1.19	2.35	0.60	1.27	8.27
01-26	2.30	2.26	0.33	0.34	0.30	0.37	0.84	1.21	2.40	0.58	1.28	9.12
01-27	2.42	2.44	0.44	0.48	-0.10	0.10	0.93	1.11	2.52	0.71	1.55	7.32
01-28	2.42	2.42	0.50	0.46	0.00	0.09	0.44	0.75	2.40	0.67	1.13	6.49
01-29	2.56	2.58	0.43	0.41	-0.13	-0.10	0.51	0.84	2.58	0.54	1.20	7.76
01-30	2.66	2.67	0.38	0.40	-0.03	0.03	0.85	1.10	2.69	0.60	1.92	8.38
01-31	2.42	2.42	0.50	0.52	0.00	0.06	0.83	1.11	2.46	0.70	1.24	6.49
01-33	2.48	2.47	0.45	0.49	0.06	0.12	1.00	1.25	2.52	0.63	1.24	7.31
01-34	2.32	2.32	0.34	0.34	0.01	0.06	0.69	1.08	2.38	0.46	0.01	6.86
01-35	2.33	2.32	0.36	0.36	0.09	0.21	0.67	1.08	2.41	0.57	1.22	9.05
01-38	2.34	2.32	0.35	0.35	0.11	0.20	0.67	0.97	2.41	0.52	0.91	8.80
01-40	2.30	2.28	0.37	0.39	0.13	0.22	0.90	1.22	2.36	0.62	1.21	7.90
01-42	2.32	2.30	0.40	0.48	0.10	0.18	1.31	1.54	2.36	0.60	1.48	8.93
01-43	2.36	2.37	0.44	0.45	-0.03	0.05	0.70	1.03	2.41	0.62	1.08	7.16
01-45	2.41	2.39	0.35	0.39	0.21	0.24	1.01	1.24	2.48	0.55	1.36	9.63
01-49	2.49	2.47	0.35	0.36	0.11	0.18	0.77	1.10	2.56	0.47	2.02	12.95
01-75	2.16	2.16	0.33	0.38	0.04	0.17	1.11	1.26	2.20	0.67	1.39	7.29
01-76	2.81	2.75	0.33	0.39	0.48	0.58	1.34	1.51	2.78	0.60	2.27	7.95
01-77	2.61	2.57	0.34	0.44	0.32	0.46	1.66	2.06	2.67	0.59	2.53	10.44

TABLE 2

01-76	2.81	2.75	0.33	0.39	0.48	0.58	1.34	1.51	2.78	0.60	2.27	7.95
01-77	2.61	2.57	0.34	0.44	0.32	0.46	1.66	2.06	2.67	0.59	2.53	10.44

TABLE 2

MINERAL COMPOSITION OF SELECTED THIN SECTIONS

Results of point-count identification of 100 grains from each thin section. Rock type after Folk (1954)

Sample No.	Percent common quartz	Percent chert and opal	Percent total Q	Percent polycrystalline quartz	Percent mica	Percent total M	Percent K-feldspar	Percent plagioclase feldspar	Percent total F	Rock Type
01-00	59	2	61	11	---	11	28	---	28	iA
01-03	64	1	65	9	---	9	23	3	26	A
01-04	55	1	56	20	---	20	24	---	24	fs G
01-05	73	---	73	2	---	2	24	1	25	A
01-07	61	2	63	9	---	9	28	---	28	A
01-10	59	1	60	5	---	5	35	---	35	A
01-11	58	---	58	9	---	9	33	---	33	A
01-13	59	2	61	8	---	8	31	---	31	A
01-19	67	---	67	3	---	3	39	1	40	A
01-23	64	3	67	6	---	6	26	1	27	A
01-26	58	---	58	12	---	12	30	---	30	iA
01-30	66	---	66	6	---	6	28	---	28	A
01-35	60	---	60	4	---	4	36	---	36	A
01-40	56	---	56	8	---	8	36	---	36	A
01-49	64	1	65	4	---	4	31	---	31	A

TABLE 3

NUMBER PERCENT OF HEAVY MINERAL GRAINS, SELECTED SAMPLES

Sample No.	Percent tourmaline	Percent zircon	Percent leucoxene	Percent rutile	Percent biotite	Percent muscovite	Percent sphene
01-01	6	22	68	4	---	---	---
01-10	4	34	54	8	---	---	---
01-19	3	60	31	6	---	---	---
01-29	4	12	74	10	---	---	---
01-45	1	69	24	4	2	---	---
01-49	4	38	50	8	---	---	---

LOCALITY 2

by

Charles F. Dodge

Locality 2 is situated along Farm Road 157, beginning on the south side of the bridge across the West Fork of the Trinity River and extending

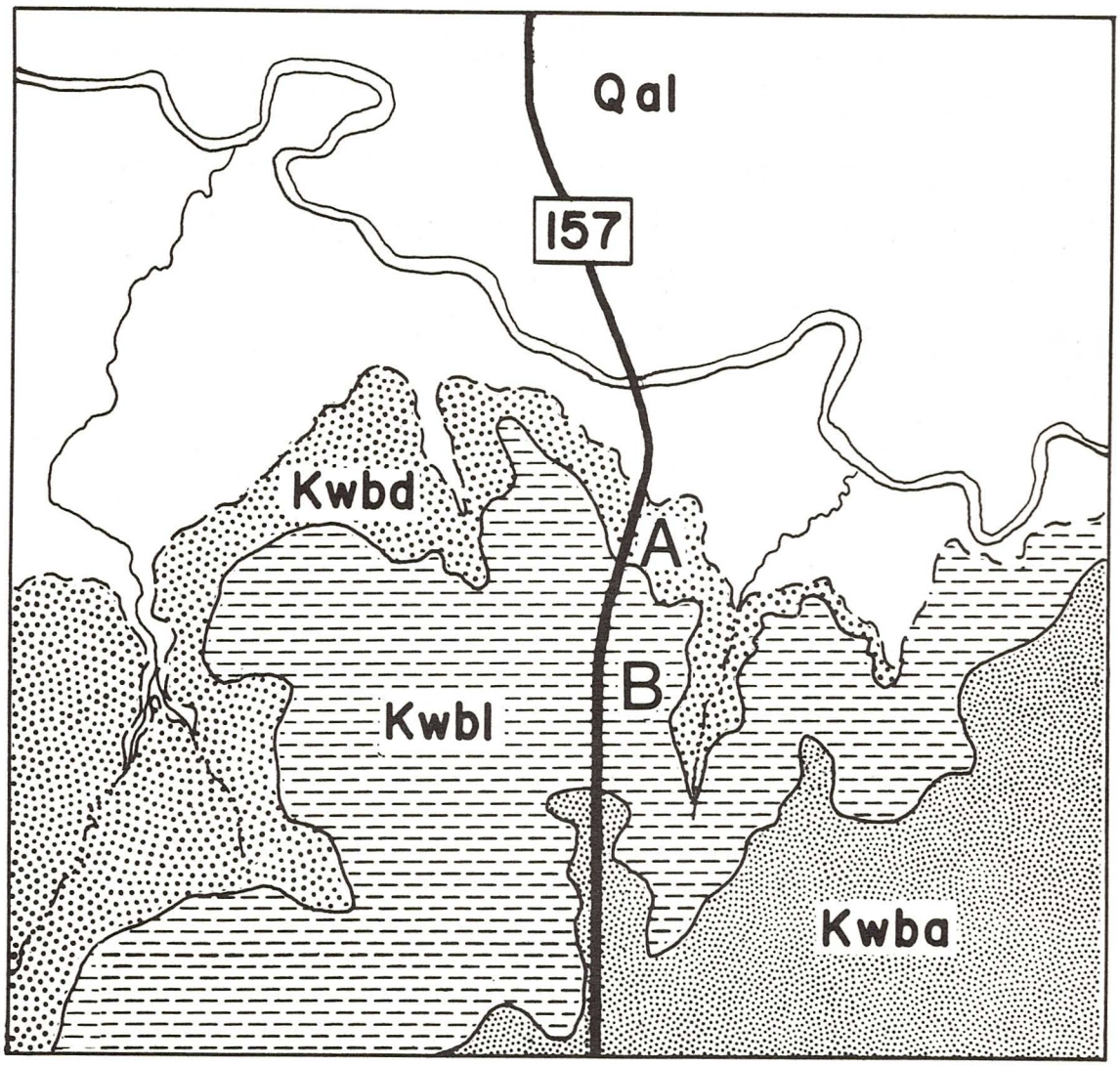


Figure 1.--Site map for Locality 2. Scale: one inch = 2,000 feet. Kwba = Arlington Member, Kwbl = Lewisville Member, Kwbd = Dexter Member, Woodbine Formation.

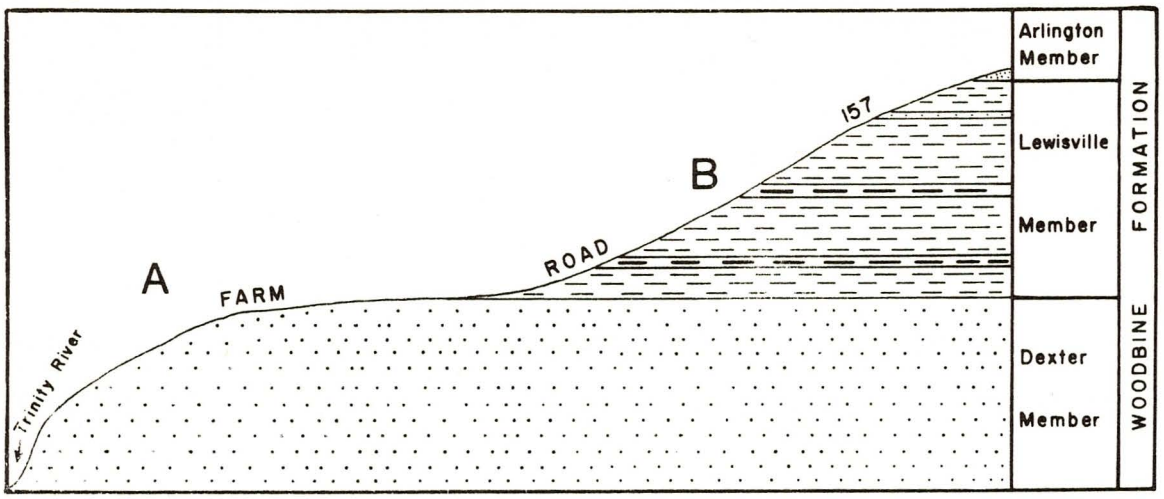


Figure 2. -- Geologic cross section from Trinity River south along Farm Road 157.

south for a distance of approximately one mile. Two sites will be visited at this locality (see Fig. 1). Most of the Woodbine Formation is exposed in ascending succession as one climbs the slope of Farm Road 157, which is cut into the south side of the river valley (see Fig. 2).

Site A

Site A extends from the river to and through the first road cut to the south, a distance of 0.6 miles. An almost complete section of the Dexter Member of the Woodbine Formation is exposed at this site; it is described below:

Woodbine Formation	Feet
Dexter Member	
White to tan, cross-bedded sandstone	15.1
Interbedded ironstone and fine, cross-bedded sandstone	0.3
White to yellow, cross-bedded sandstone; forms ledges	3.0
Gray to tan clay	0.3
Yellow to red, laminated sandstone	0.5
White, cross-bedded sandstone, weathering to shades of brown	8.3

LOCALITY 3

by

C. L. McNulty, Jr.

and

Bob H. Slaughter

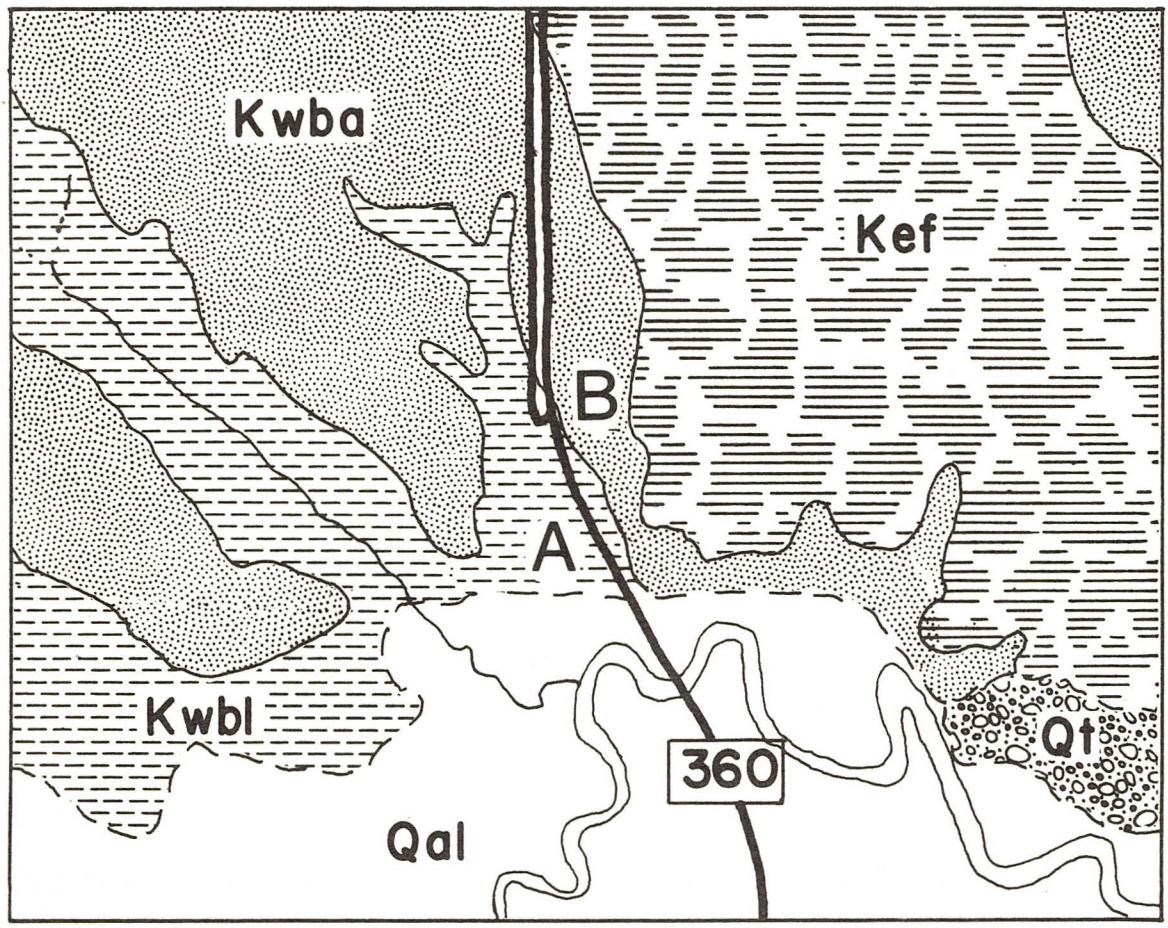


Figure 1.--Site map for Locality 3. Scale: one inch = 2,000 feet. Kef = Eagle Ford Formation; Kwba = Arlington Member, Kwbl = Lewisville Member, Woodbine Formation.

Site A

Site A is a road cut on the east side of State Highway 360 immediately north of the Chicago Rock Island and Pacific Railroad overpass. In it are

exposed 27 feet of Lewisville Member and 12 feet of Arlington Member (Fig. 2).

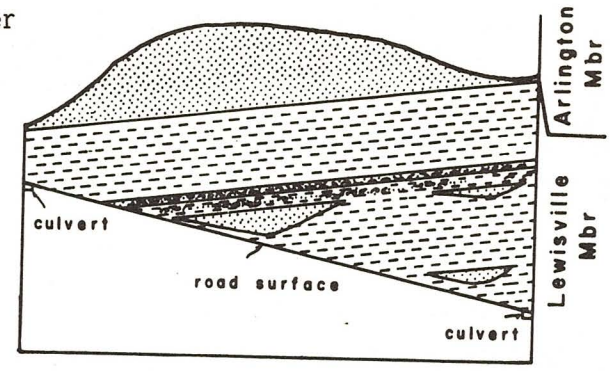


Figure 2.-- Site A. one inch = 300 feet horizontally and 20 feet vertically.

The Lewisville is mainly gray jarositic to black lignitic, gypsiferous shale, but it contains many lenses and thin beds of light brown, quartz sandstone. This site provides a superior view of the nature and abundance of sandstone bodies in the Lewisville Member.

Of particular interest are two three- to six-inch beds of coquinoid lignitic, gray quartz sandstone, which may be identified by their reddish brown color of weathering. The molluscan fauna is dominated by corbulids, arcids, and ostreids. Macrurous decapods, lingulid brachiopods and fragmentary vertebrate remains are also present. Chelonial debris appears to be the most abundant of the vertebrate material, but galeoid, batoid and holostean fishes, crocodilians, and even archosaurian fragments occur.

The Arlington Member is a light brownish gray, coarse-grained, quartz sandstone. At first glance the unit appears to be thick bedded and massive, but close examination of clean exposure, as at Site B, reveals that it is considerably cross-bedded and lenticular in structure. Many lenses are coquinoid, and the pelecypods are mainly taxodont and desmodont, ostreid, or a mixture of the two (Stephenson, 1952). Patches of ostreid coquina and scattered lenses of acanthocerid ammonites occur at the top of the Member in this exposure. Also present at or near the top are irregular patches and lenses of sandy quartz and phosphorite conglomerate with abundant vertebrate debris, such as will be seen better at Site B.

Site B

Site B is an exposure in bar ditch and road cut along the north side of the service road to Frontier Airlines Operations Building in the southwest quarter of Southwest International Airport. It is 200 yards north of Site A.

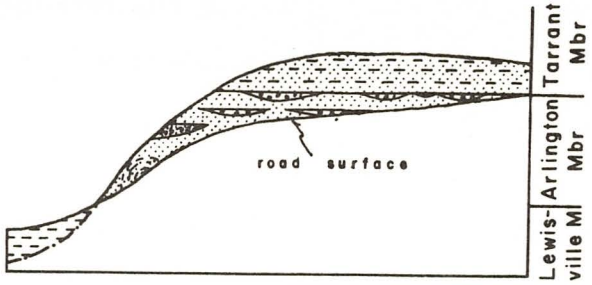


Figure 3.-- Site B. one inch = 300 feet horizontally and 20 feet vertically.

The exposure shows six feet of gray, jarositic Lewisville shale and 12 feet of brown, thick-bedded Arlington sandstone. The lower six feet of sandstone contain ill-defined ironstone concretions of three to six feet in diameter. The Arlington is overlain by four feet of yellowish brown, poorly indurated, argillaceous quartz sand, apparently of the Tarrant Member (Fig. 3).

The main point of interest at this site is the distinctive but erratic development of sandstone conglomerate in the upper four feet of the Arlington Member. It is peculiar in an abundance of phosphoritic granule-pebbles and vertebrate fragments, which are mostly fish teeth. The conglomerate is most continuous at the top of the Arlington, but it is common also at a horizon about two feet below the top and may occur much lower (Stephenson, 1952, p. 13). Although the conglomerate has excited stratigraphic speculation for forty years, nothing has been published about the vertebrate fauna.

Stratigraphic Inference from the Conglomerates.--Stephenson (1929) was one of the first to note the association of glauconitic-phosphoritic rudite, fish debris, and uneven, if not burrowed or bored, contacts. He considered them evidence of disconformity. Among the examples cited in this argument was the conglomerate of Site B, which was presented as powerful evidence of disconformity at the Woodbine-Eagle Ford contact from Tarrant County south to the Woodbine pinchout. The significance accorded the conglomerate and associated contact has changed with time (Stephenson, 1946, 1952), and the unit is presently considered indicative of local unconformity within the upper Woodbine. It may prove a fragmentary record of strand passage prior to Eagle Fordian inundation.

EXPLANATION OF PLATE I

Figure 1a-c: Hybodus sp., teeth, X 3.5; a = internal aspect, b = external aspect, c = lateral aspect.

2: Hybodus sp., medial fin spine, X 3.5; left-lateral aspect.

3a-c: Odontaspis sp., teeth, X 3.5; a = internal aspect, b = external aspect, c = lateral aspect.

4a-b: Odontaspis gracilis [=Scyllium gracilis Williston], teeth, X 3.5; a = internal aspect, b = lateral aspect.

5a-c: Lamna sulcata Geinitz, teeth, X 1.25; a = internal aspect, b = external aspect, c = lateral aspect.

6a-c: Lamna planidens [=Scyllium planidens Williston], teeth, X 4.0; a - internal aspect, b = external aspect, c = lateral aspect.

7a-c: Onchopristis dunklei McNulty and Slaughter, basal portion of barbed, rostral teeth, X 4.0; a = dorsal aspect, anterior toward left; b = ventral aspect, anterior toward right.

8a-c: Squalicorax sp., teeth, X 3.5; a = internal aspect, b = lateral aspect, c = external aspect.

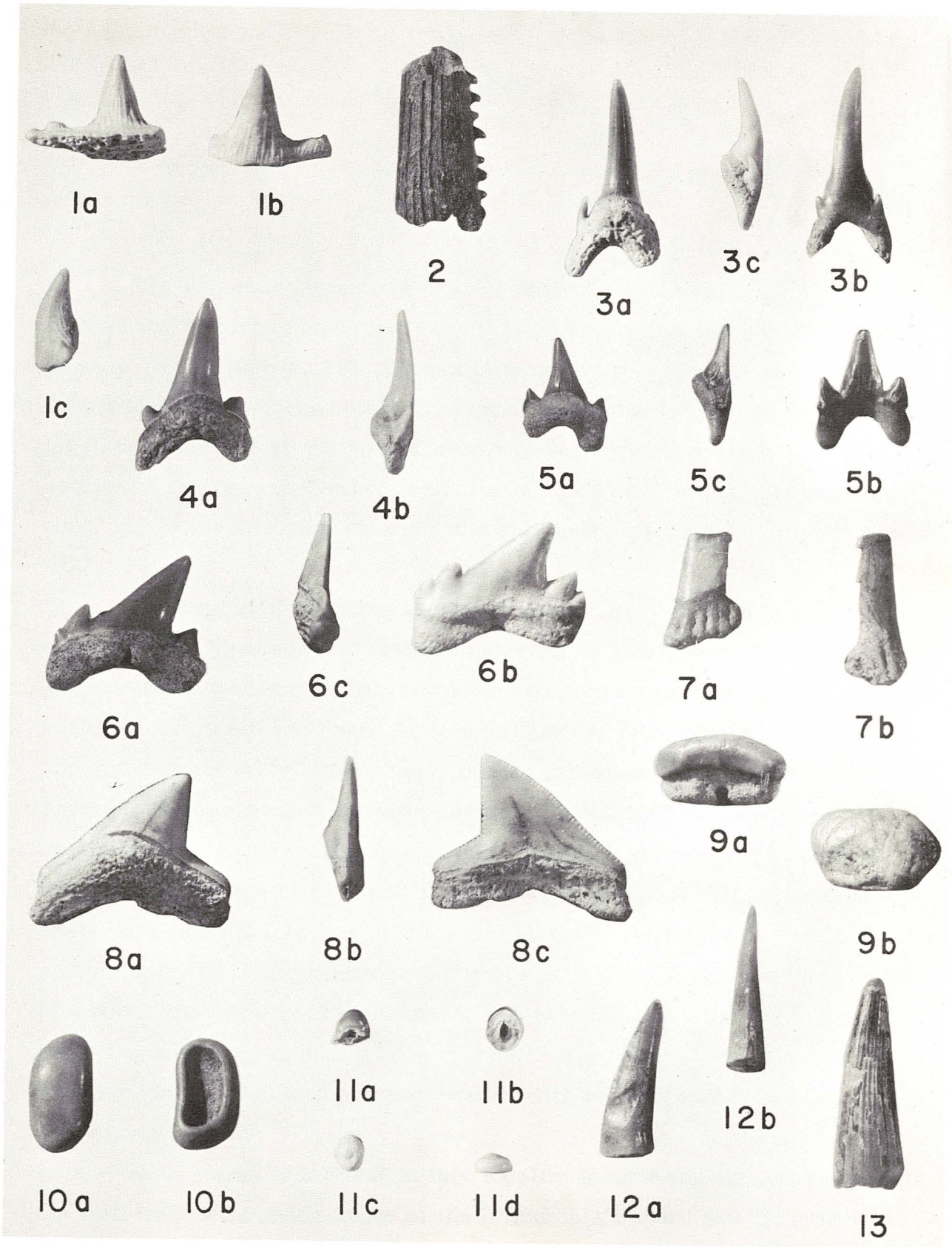
9a-c: Hypolophus cf. H. sylvestris White, durophagous teeth, X 4.0; a = external aspect; b = occlusal aspect, anterior toward top.

10a-b: Pycnodontid triturial teeth, X 2.0; a = occlusal aspect, b = basal aspect.

11a-d: Semionotid triturial teeth (Lepidotus mantelli Agassiz), X 1.25; a = lateral aspect of peripheral tooth, b = basal aspect of medial tooth, c = occlusal aspect of medial tooth, d = lateral aspect of medial tooth.

12a-b: Enchodus sp., primary teeth, X 2.25; a = lateral aspect, anterior toward left; b = posterior aspect.

13: Crocodilian tooth, X 1.5; lateral aspect.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2
3a
3c
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PLATE I

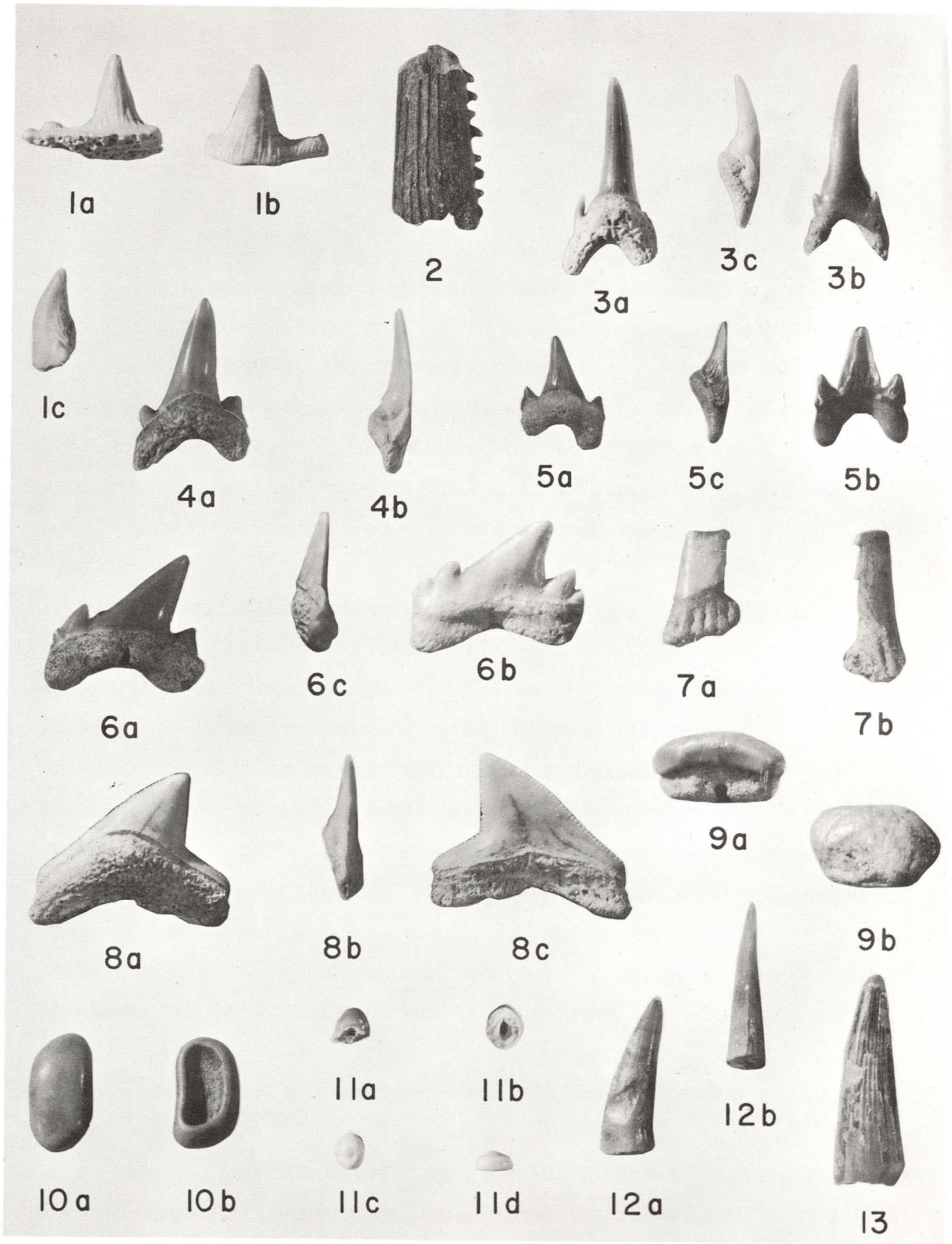
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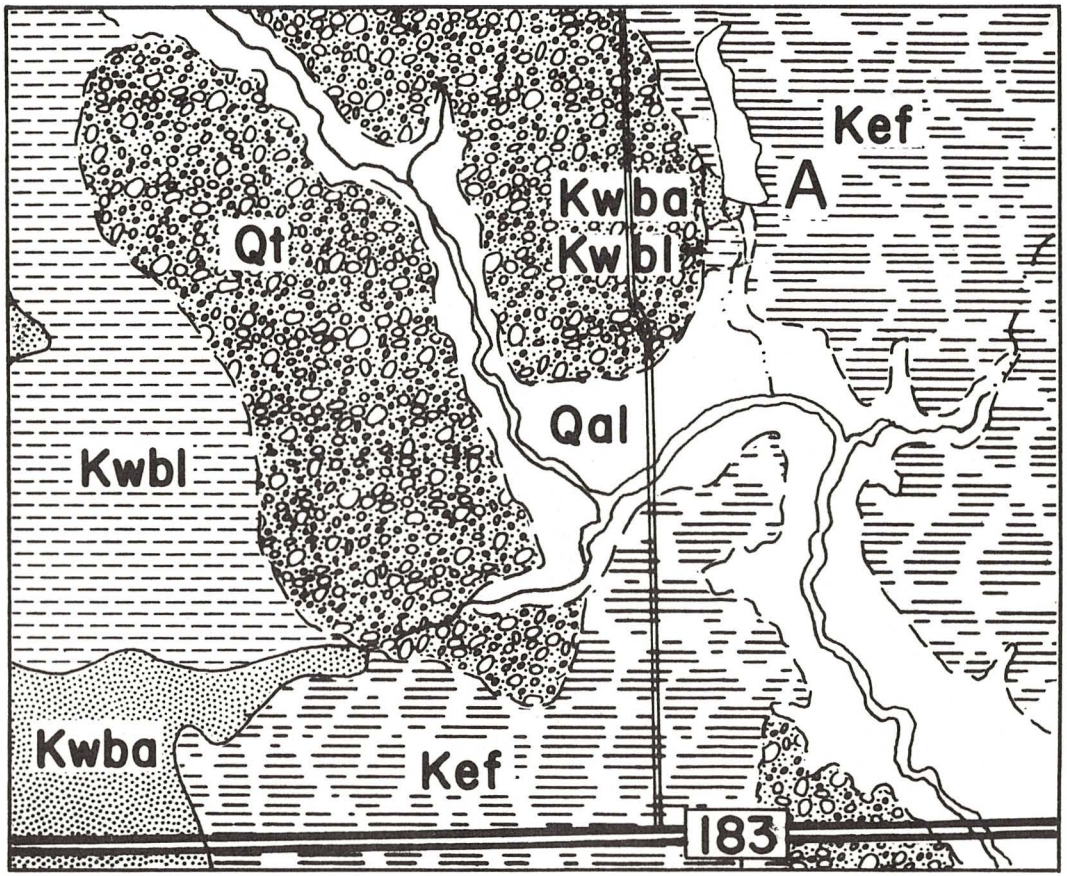
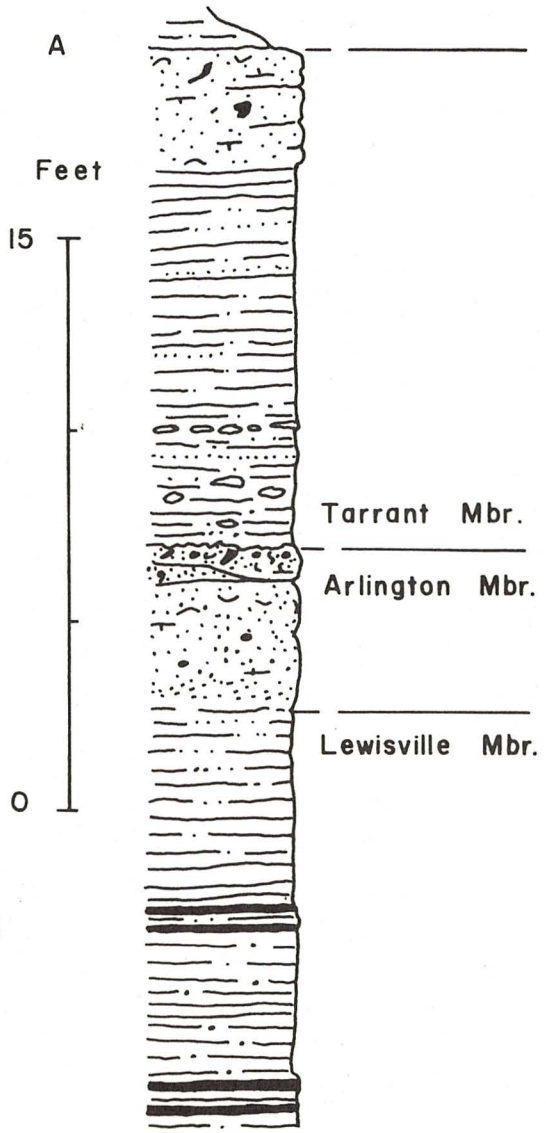
PLATE I





EXPLANATION: The letter "A" is located just southeast of the Locality 4 exposure. Kwbl = Lewisville Member, Kwba = Arlington Member, Woodbine Formation; Kef = Eagle Ford Formation (including Tarrant Member at base). Scale: one inch = 2,000 feet.